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HISTORY.

EARLY NOTICES OF THE MISSOURI RIVER AND INDIANS.

(THIRD PAPER.)

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Father James Marquette, who, in company with Joliet of Quebec, explored the Mississippi from the Wisconsin to the Arkansas, in 1673, did not mention the Missouri in his narrative of the voyage except under the name of Pekitanoui, but on his map accompanying the relation, the river is located for a part of its course, and in nearly their right positions the villages of the Missouri Indians are mentioned under the names of Ouchage (Osage), and Emissourites (Missouris).

This map is still preserved with the original relation in St. Mary's College, at Montreal, Canada, and bears, so far as I have been able to discover, the first mention by name of the Missouri Indians. That part of Marquette's map which refers to the country west of the Mississippi must have been based on information derived solely from the Indians, but subsequent investigations have proven its correctness. The first explorers of the Missouri found the tribes, located by Marquette on the course of that river, to be nearly as he placed them, which is as follows: Ouchage (Osage), Emissourites (Missouris), Kansas, Otontanta (Otoes), Maha (Omahas), Pana (Pawnees) and Pahoutet (Pah Ute).

Succeeding Marquette and Joliet, there came to the Illinois country in 1680, to explore the Mississippi Valley, Robert Cavelier, de la Salle, a true rover and ex-

plorer, self-reliant, strong in his own resources, too imperious and dictatorial in his manner to win the confidence of those under his command, but possessed of wonderful energy and a mind charged with grand schemes of western discovery, colored with expectations of pecuniary profit to himself and associates. After spending nearly two years in preparing for his voyage, making peace with the Indians, building forts, journeying to Canada and back, La Salle and his party consisting of twenty-three Frenchmen and thirty Indians, left the mouth of the Illinois River December 13th, 1681, and entered the Mississippi. Going down fifteen or twenty miles, they camped for the night within the limits of what is now the State of Missouri. Of this party, who two hundred years ago camped for a wintry night at the junction of the Missouri and Mississippi, three were destined to imperishably connect their names with the history of the valley, La Salle, Father Zenobius Membre, and Henri de Tontz. Of this voyage of La Salle's down the Mississippi there are six narratives, written by members of the expedition, though all of the writers do not mention this camping near the Missouri.

The most explicit account on this point is that of Nicolas de la Salle, whose narrative has lain in manuscript, unpublished, until the recent volumes of Pierre Margry brought it to light. The writer, though of the same name, was not a relative of the commander of the expedition, and at that time was quite a young man. Twenty years later he was made royal commissary of Louisiana, and filled the office for seven years, to the great annoyance of Governor Bienville, with whom he had many contentions. His narrative of the voyage down the Mississippi was written in 1685, and in it he says, "The first day we camped six leagues on the right side, going down the river near the mouth of a river which falls in the Mississippi; it is called the river of the Missouris. This river comes from the northwest and is thickly settled, judging by what the savages say. The Panis (Pawnees) are on this river very far from the mouth."

The location of the camp, as mentioned by this writer, would be within the limits of either St. Louis or St. Charles county, according as it was on the right or left bank of the Missouri. The most prominent member of the expedition next to its commander, was Henri de Tontz, son of the governor of Gaeta, a native of Italy. He entered the French army in 1668 and lost a hand which was supplied by one of iron, from which fact he was frequently called the "iron hand" by the Indians. He joined La Salle at Rochelle in July, 1678, and was among the few men admitted to the confidence of his commander. In his relation of the "Enterprises of M. de la Salle from 1678 to 1683," written at Quebec, November 14, 1684, he recounts the voyage down the Mississippi, and says, "The Indians having finished their canoes we descended the river and found at six leagues on the right a river which falls into the river Colbert, coming from the west and appearing as large and important as the great river. According to the reports of the savages, it is called Emissourites, is abundantly settled with people. There are also on this river villages of savages, which make use of horses to go to war and to carry the meat of the buffalo which they kill." The nation thus referred to was the Pawnees and though they were located far in the

interior they seem to have been early known to the French. The fact that they possessed horses was frequently alluded to by early French annalists. In the account quoted it will be seen that Tontz does not mention that the party camped near the Missouri, but does corroborate M. de la Salle in all other particulars. In the year 1693, nine years after, he addressed a memoir to the King of France, setting forth his services in the valley of the Mississippi, and especially reciting his undertakings in connection with La Salle. In giving an account of the first voyage down the Mississippi, he says, "We descended the river (Illinois) and found six leagues below on the right, a great river which comes from the west, on which there are numerous nations. We slept at its mouth. The next day we went on to the village of the Tamaroas six leagues off on the left." Here it will be seen that Tontz agrees with the young La Salle as to the place of camping on the night of December 13th, though from his language the inference could be drawn that the party spent the night in their canoes, were it not for the positive language of his companion, who says they camped.

La Salle's antipathy to the Jesuits was so great that he would allow none of them to accompany him on his expeditions, but chose his spiritual advisers from the medicant order of Recollects. Two of these friars accompanied him to the Illinois country, Louis Hennepin and Zenobius Membre. The former was sent in February of the preceding year to explore the Mississippi north from the mouth of the Illinois and was taken a prisoner by the Sioux, while the latter accompanied the expedition south from the same place, and has left two accounts of the voyage. In one, which is in the form of a letter dated June 3, 1682, no mention is made of any stop in the vicinity of the Missouri. In the other, which is by far the best account of the voyage in existence, he says, "The floating ice on the river Colbert kept us at this place (the mouth of the Illinois) till the 13th of the same month, when we set out and six leagues lower down found the Osage (Missouri) coming from the west." He makes no mention of stopping, in direct terms, but continues his narrative as follows: "On the 14th, six leagues further we found on the east the village of the Tamaroas who had gone to the chase." The inference to be drawn from this language, is that expressed by Tontz who says of the Missouri, "We slept at its mouth." As the reverend father says they found the river on the 13th and the Tamaroas on the 14th though they were but six leagues apart, he does not intend to convey the idea that the night of the 13th was spent in traveling.

The remaining account of the voyage is found in the *proces verbal* of the taking possession of Louisiana, made by James de la Metairie, at the mouth of the Mississippi, April 9, 1682. Metairie was a notary from Fort Frontenac accompanying the expedition, and while it seems to have been the intention of La Salle to claim possession of the whole territory watered by the Mississippi and its branches, the notary is very obscure in his enumeration of rivers and Indian nations. This defect probably arose from an ignorance of the geography of the country. He does not mention the Missouri River at all, but contents himself with saying that they left the Illinois river on the 13th of December, 1681, and

arrived at the village of the Tamaroas on the 14th. From the extracts given, it is conclusively shown that La Salle and his party spent one night on Missouri soil, on their voyage to the sea, whereby France gained an empire and the world its first knowledge of the mouth and full course of the Mississippi. Conceding that De Soto's expedition reached the New Madrid country in 1542, this visit of La Salle's party in 1681 was the second in point of time made by white men to the country comprised within the borders of our State.

The Missouri and Illinois Indians, though of entirely different stock and living two hundred miles apart, were always on very friendly terms, as I have shown in a former paper. Another incident bearing on this is found in an encounter mentioned by Tontz in his account of the return of La Salle's party up the river. After mentioning that La Salle had been left at Fort Prudhomme sick, and that he had been directed to push on with the main part of the company, and that they had passed the mouth of the Ohio, he says: "Four days after I perceived a smoke and went to it. There came out of the forest thirty Tamaroa warriors with bows bent, making their war cry at us. I presented the calumet to them and one Illinois who was among them having recognized me exclaimed, "It is my comrade, they are French." We landed and passed the night with them. They designed to kill us, but as they were part Illinois, Emissourites and Tamaroa, the Illinois prevented the attack." Here were the Missouris visiting the Tamaroas and uniting with them to go on the war-path. Tontz speaks of the Tamaroas as though they were a distinct tribe, when in reality they were a branch of the Illinois, who had established their village on the banks of the Mississippi. Those familiar with the history of the trials endured by La Salle in his endeavors to establish a colony on the Illinois River will recollect the loss of his vessel, the Griffin, containing the greater part of his stores, and how he suspected that the pilot had purposely wrecked the vessel and taken his goods to the Sioux country intending to establish himself as a trader. From letters written at the time, but only recently published in the Margry volumes, it appears La Salle was of the opinion that his pilot had been captured and held as a prisoner among the Missouris and other tribes west of the Mississippi. In a letter dated Chicago Portage, June 4, 1683, to M. de la Barre, the newly appointed governor of New France, he gives an account of a story told him by an Indian lad, as follows: "The lad had been taken by the Pawnees, then by the Osages, who had given him to the Emissourites, and they to the nation from which I had him. He told us several times that he had seen two Frenchmen, three years ago, prisoners among the Matchinhoa, whom he described to us in such a manner that I could not doubt but one of them was my pilot, that they had been taken in the Mississippi River, which we call Colbert, ascending toward the Sioux, with four others, in birch bark canoes, loaded with merchandise, among which were several large grenades such as I had left in the barque; that the pilot had exploded one in the presence of one of these barbarians, and having made them understand that with similar ones he would burn the villages of their enemies, if they preserved his life. That he did not yet understand the language of those with whom

he was when my little savage saw him. They had come in peace to the village of the Missouris where he then was and exploded a similar grenade." If it were possible to verify this statement of the Indian lad, it would establish the date of the first visit of white men to the Missouris, but unfortunately, though La Salle gives additional circumstances which he supposes relate to the captivity of his pilot, and reiterates the whole story in other letters, the evidence is far from conclusive that his pilot was ever among these Indians, either as a captive or otherwise.

La Salle's aversion to the Jesuits often led him to extremes, and his dislikes of others frequently placed him in an unenviable light.

He was at emnity with Louis Joliet over matters which had occurred at Quebec, relating to the fur trade. Frontenac, La Salle, La Forest, Du Sheet and others, were ranged on one side and Joliet, Bienville and brothers, the intendant Duchesneau and others, on the other. I haven't space to explain the quarrel, but refer to it to show the animus of what follows. Joliet had been associated with Marquette in exploring the Mississippi, and on his map of the country, over which they passed, had made an endorsement approving the route to the Mississippi by way of the Chicago portage to the Illinois river. This approval by Joliet drew the condemnation of La Salle before he passed over the route, and in several of his letters, he took occasion to refer to the impracticability of it. In one recently published by Margry, he says: "The waters being always low in the month of March, it would be easier to effect the transportation from Fort St. Louis, (on the Illinois) to the lakes by land; by making use of horses, which it is easy to have, there being numbers among the savages called Pana, Pancassa, Panimaha and Pasos, at some distance, to be sure, to the westward, but with which an easy communication may be had, either by the river of the Missourites which empties into the river Colbert, if it be not the principal branch of it, and is always navigable for a distance of more than four hundred leagues to the west, or by land, so bare is the country between these people and the river Colbert, that it is a wide prairie by which they may be easily brought overland."

I have quoted this to show to what extremes La Salle was willing to resort rather than approve the route Joliet had endorsed and which eventually became the thoroughfare for that country; also to show that he regarded the horses possessed by the Pawnees as a factor to be used in the future development of the country. The Indians he refers to were all Pawnees, called by different names. He had already received a conditional patent for the vast region in which he was to labor at discovery, and probably regarded the horses possessed by the savages as one of the elements of his future prosperity. The Fort St. Louis referred to was near the village of the Kaskaskia Indians, on the Illinois river and was the place round which he hoped to gather the Indians of the West and South for the purpose of trade. Referring to this, he says in one of the Margry letters: "The arrival of the Ciscas and Chaouenon was followed by the return of the Illinois. The Tamaroas alone number three hundred cabins. Now all these nations come here to settle. The village of Matchinhoa, of three hundred fires, is thirty

leagues from the fort, to which it has also come and a part of the Emissourites and others, which together, form a village of two or three hundred fires. I have established their fields at four leagues from the fort."

Perhaps it is unnecessary for me to say that this scheme proved fruitless, and that the Missouris and other tribes soon returned to their own villages.

M. Bossu, a captain in the French Marines, spent several years in the Mississippi valley, and on his return to France, published at Paris in 1768, his travels in Louisiana, and has the following concerning the Missouris: "Baron Porneuf, who was governor of Fort Orleans, established in that nation, and who knows their genius perfectly well, has informed me that they were formerly very warlike and good, but that the French hunters had corrupted them by their bad conduct. They had made themselves contemptible by frauds in trade, they carried off Indian women and performed other irregularities which irritated the Missouris against them, and therefore, during M. de Bienville's government, they massacred the Sieur Dubois and the little garrison under his command, and as no soldier escaped, we have never been able to know who was right and who was wrong." At another place the author relates a long story, the substance of which is as follows: A trader from the French settlements deceived the Missouris by making them believe that powder would grow in their fields, thereby inducing them to purchase his stock and sow it for the purpose of raising a crop. The Missouris retaliated for this deceit by taking the goods of the next trader that visited them, without giving any furs in exchange. A subsequent trader turned the whole transaction to his own profit by bringing with him a keg of powdered charcoal and after inducing the chiefs to enter his hut for the purpose of trade, pretended to become crazy, and threatened to discharge his pistols into the keg of charcoal, which the Indians supposed to be powder, if the friends of the chiefs in the hut with him, did not bring beaver enough to pay for all the goods taken from the other trader. The Missouris supposing their chiefs to be in imminent danger, complied with the demand and brought in piles of beaver skins, when the crafty trader announced that he had recovered his senses. He then poured water on the charcoal to prevent a recurrence of the danger to his friends in case his senses left him again. By such schemes were the Indians defrauded by the French, who came among them for the purpose of trade.

The same author gives an instance of what he terms jugglery by one of the Missouris, as follows: "I will give you another account of the superstition of these people, and of the divine service they give to horrid animals. In 1756 there arrived a deputation of Indians at Fort Chartres, of the nation of Missouris. There was an old woman among them who passed for a magician. She wore around her naked body a living rattlesnake, whose bite is mortal if the remedy is not applied the moment after. This priestess of the devil spoke to the serpent, which seemed to understand what she said, 'I see,' said she, 'thou art weary of staying here, go then, return home, I shall find thee at my return.' The reptile immediately ran into the woods and took the road to the Missouris.

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"If I had been inclined to be superstitious, I should have told you that I had seen the devil appear to these nations under the figure of a snake. Many missionaries have been willing to persuade us in their relations, that the devil appears to these people in order to be adored by them; but it is easy to see that there is nothing preternatural in it, the snake of the pretended witch did not go to her country, it was a mere juggle." Of the natural history of the country, the author remarks: "In the country of the Missouris there are magpies, only different from the European ones by their plumage, their black and white colors being shaded. The Indians make ornaments for their hair of them. On going towards the head of the river of the Missouris, you find all sorts of wild beasts. The wild goats and their young ones are very common at certain seasons. These animals are very lively and pretty. The French that have eaten of them assure me that the young venison is as good as the best mutton."

ARCHÆOLOGY.

WHO WERE THE MOUND-BUILDERS?

BY J. F. SNYDER, M. D.

"The conviction is daily gaining strength that the race of Indians found in occupancy of this country when it was discovered by the Europeans were the people, or the immediate descendants of the people, who built the mounds; and students of American Archæology now agree that mound-building was practiced by some of the tribes down to a comparatively recent date."

This opinion I recently expressed in a paper, published in the *Missouri Republican*, on "the death and resurrection of Black Hawk," and it embodies two propositions which I maintain to be true. It was quoted in the January number of the REVIEW with the following dissenting comment: "We doubt whether Professor Putnam, or any other first-class authority, will endorse this statement without considerable qualification."

In this criticism I am left in uncertainty as to the exact nature and amount of "qualification" the REVIEW regards as "considerable" or essential for the endorsement of my statement by first-class authorities; and also, as to precisely who, in the editor's estimation, besides the eminent gentleman named, constitute authorities of the first-class. Nevertheless, I will reiterate and specify, without fear of successful contradiction, that the conclusions to which I have arrived, as above quoted, are accepted with very slight, if any, qualifications, by such authorities as Professor Putnam and Lucien Carr, of the Peabody Museum of Ethnology; E. G. Squier, author of "Ancient Monuments of the Mississippi Valley, Etc."; Prof. Charles Rau, Curator of the Smithsonian Ethnological Department;

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Col. C. C. Jones, Jr., author of "Antiquities of the Southern Indians, Etc."; Prof. Lewis H. Morgan, author of "Ancient Society, Etc."; Prof. N. H. Winchell; Prof. Joseph Jones, author of "Aboriginal Remains of Tennessee;" Dr. John J. R. Patrick, John P. Jones, Esq., and a host of other cultured students all over the country, who have expended years in diligent research and laborious investigation of American antiquities.

But we cannot rely upon mere opinions, however dogmatically asserted, in matters of natural science, to influence the convictions of thinking men. It is only reasonable that, in the issue joined, some of the deductions and facts upon which the views I have advanced are based, should be demanded and fairly considered. The proper presentation of all the evidence and a thorough discussion of the data forming that basis would require the space of a large volume and can only be epitomized in the limits allotted to this paper.

Though a mound of earth was erected on the battle-field of Waterloo, by order of the English government, only sixty-seven years ago, it is not seriously maintained by any one that the construction of an earthen mound necessarily requires a high degree of engineering skill or mathematical talent, or is in any view the achievement of special genius. On the contrary, earthen mounds are the product of only muscular effort, and were made by primitive people because they were the form of tumuli requiring the exercise of the least skill; the simplest and most easily constructed as well as the most enduring. Mound building, for the inhumation of the dead and in veneration of their memory, and for other rites of a sacred character, and in commemoration of important events, has been practiced, not exclusively by any one branch of the human family, nor only in any one era of the world's history, but alike by savage, barbarian and semi-civilized races, in all quarters of the globe, from the earliest to modern times. The early New Zealanders, the Celts, Gauls, Japanese, Scythians, Scandinavians, etc., heaped mounds over the bodies of their distinguished dead, and the ancient Greeks also erected mounds over the remains of their heroes slain in battle.

The mounds of the Mississippi basin are in no essential particular different from those seen on the plains of Europe or the steppes of Asia; and surely none of them, in conception or execution, are above the capacity of the Indians who entertained and fought De Soto, and whose descendants were subsequently studied by Adair, Bartram, Du Pratz and Charlevoix. The internal evidence of the mounds in this country, and the obvious uses of the numerous implements and ornaments of stone, shell, bone, etc., manufactured by their builders, and often found buried with their remains, imply that the mound-builder's methods of life, arts of subsistence, customs, habits, and mental characteristics were precisely identical with those of the Florida Indians at the date of their primal contact with Europeans; and were the natural resultants of the necessities, passions and superstitions of a people occupying at best a middle plane of barbarism. In all the pre-historic remains of the Mississippi Valley not the slightest proof has been found to sustain the theory that it was at any time occupied by a race superior to the Mandans, Choctaws and Natchez; and there is not a sound reason for attributing the author-

ship of those remains to a distinct and now extinct people, when we know that those Indians were in possession of all of the arts, practices and superstitions claimed for that imaginary race. The builders of the mounds knew nothing of astronomy, mathematics or architecture. They had no knowledge of metals, having never even discovered the reduction of galena, the most readily fused of all ores. They lived in temporary huts of frail, perishable materials, and had not advanced to the art of constructing stationary abodes of clay or stone. Their wants had developed mechanical skill of no mean order, as is manifested by their coarse fabrics, woven of hemp and bark, their pottery, stone weapons, domestic implements, ornaments, etc. They had progressed in the arts of food production beyond reliance upon roots, mollusks and fruits to a rudimentary cultivation of the earth and the storing of provisions for future use. They made toys for the amusement of their children, and devices for playing games; but the chief pastime of the males, judging from the quantity and quality of the weapons and defences they left, was war and the chase. They believed in a future state of existence; buried their dead with tender care, and burned their captives without mercy. There is not the slighest foundation for the belief so frequently expressed, that they lived in an organized "Empire," or under any other form of political government; or that they possessed any description of written language or system of hieroglyphics; or had any formulated mode of worship; or entertained religious sentiments more elevated than the grossest superstitions.

This summary sketch accurately depicts the status of the mound-builders, and is a correct representation of the condition of the southern Indians when first discovered.

Comparative craniology has been invoked, by eminent ethnologists, to support the the theory of a pre-existent race superior to the Indians, with results by no means satisfactory. The mean cranial capacity of one people may be less or greater than that of another; but, so far no appreciable difference in mean internal capacity has been discovered between the crania of some of the Indians who built mounds and some who did not; and attempts to establish racial distinctions upon the shape of the skull by classing the one *Brachycephalic* (round skulls), and the other, *Dolicocephalic* (long skulls), is unscientific, arbitrary and not sustained by observed facts. Dr. Richard Owen remarked: "From an old and well-filled European grave yard may be selected specimens of *Klimocephalic*, *Conocephalic*, *Braehycephalic*, *Dolicophalic*, *Platycephalic*. *Leptocephalic* and other forms of crania equally worthy of penta or hexa-syllabic Greek epithets." This is true also of any large collection of crania of any race; and in a given number of skulls of ancient (mound-builder) and modern Indians, excepting such as have been artificially deformed, all the above types will probably be found. For it cannot be seriously contended that the heads of any people have all been for centuries cast in the same mould.

In the statement that mound-building had been practiced by some of the tribes down to a comparatively recent date it may be necessary to explain that the primal contact of the whites with the Indians of this continent; or, in other

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words, the beginning of America's history, is accepted as "recent" compared to the vast antiquity claimed for the rise, grandeur and final extinction of the mound-builder's "Vanished Empire." With this "qualification" I will briefly cite, in corroboration of my statement, a few well-authenticated instances of comparatively recent mounds, or such as are known to have been erected subsequent to the intrusion of civilization and its arts.

Mr. Squier, in the second volume of "Contributions to Knowledge," of the Smithsonian Institution, describes mounds and earthworks extending from Canada to the Susquehanna, which were found to contain ornamented pottery, pipes, stone axes, hammers and discs and other stone-age implements identical in shape and material with similar specimens found by him in the Ohio mounds; and bone awls and needles together with iron axes, glass beads, cast copper hatchets, kettles of iron, brass and copper, and other articles of European manufacture. The building of these mounds he was forced to assign to the Iroquois within "comparatively recent dates;" though in every essential character they were exactly like the older mounds in central Ohio. In this (Cass) county, a few years ago, a mound, eight feet high by twenty-five feet in diameter, situated on a point of the Sangamon bluffs, was opened and found to contain the remains of one human skeleton walled around with rough stones, over which the earth had been heaped. With this skeleton were found a small earthenware cup, a few flint implements and an iron gun barrel. In another low mound six miles from this city, removed some years ago in opening a new road, the remains of several individuals were thrown out, together with stone axes, flint arrow-points, broken pottery, glass beads and brass rings. In the skeleton hand of one of the dead was a beautiful pipe, of polished serpentine, cut in the exact image of a frog. Col. C. C. Jones, Jr., found in a mound, not far from Savannah, with the bones of a skeleton at its base, an earthen pot, a few arrow-heads of flint, a stone celt, and the oak handle, with part of the blade of an old-fashioned sword. Bartram, as late as 1729, saw the Choctaws take from their tribal bone-house a large number of the remains of their dead in rude coffins, and after piling them up in a pyramid, heap over them a great mound of earth. Dr. Sternberg, of the U. S. Army, in a paper read in 1875, before the American Association for the Advancement of Science, describes his explorations of certain mounds near Pensacola, Florida, in which were found pottery, hematite paint rocks, flint weapons, perforated shell ornaments, blue-glass beads and pieces of iron. The old Winnebago chief, Winneshiek, said the mounds at Lanesboro, Minnesota, were erected by the Sioux, many generations before, in commemoration of a great victory the latter had achieved over his people. Tomochichi pointed out to Gov. Oglethorpe a large mound near Savannah, Georgia, which he said had been raised over the remains of the Yamicraw Chief who had, many years before, entertained a red-bearded white man, who had sailed up the Savannah River, in a large vessel, to the Yamicraw Bluffs.

The Natchez Indians when expelled from Louisiana, by the French, in 1728, retired to the neighborhood of Natchitoches and there built a mound of consider-

able size. Featherstonhaugh states that the Osages erected a mound over the corpse of one of their chiefs, called by the French, Jean Defoe, "enlarging it at intervals for a long period until it reached its present height." Catlin states that the Mandans erected mounds over their dead; and he gives the following account of the burial of Black Bird, a noted chief of the Omahas, about the year 1800, on the top of the Missouri bluffs, sixty miles from the present city of Omaha: "The O-ma-haw village was about sixty miles above this place; and this very noted chief, who had been on a visit to Washington City, in company with the Indian agent, died of the small-pox, near this spot on his return home; and, whilst dying, enjoined on his warriors who were about him, this singular request, which was literally complied with. He requested them to take his body down the river to this, his favorite haunt, and on the pinnacle of this towering bluff, to bury him on the back of his favorite war-horse, which was to be buried alive under him, from whence he could see, as he said, 'the Frenchmen passing up and down the river in their boats.' He owned, amongst many horses, a noble white steed that was led to the top of the grass-covered hill, and with great pomp and ceremony, in presence of the whole nation and several of the fur-traders and the Indian agent, he was placed astride of his horse's back, with his bow in his hand, and his shield and quiver slung—with his pipe and his medicine bag—with his supply of dried meat, and his tobacco-pouch replenished to last him through his journey to the 'beautiful hunting-grounds of the shades of his fathers'—with his flint and steel, and his tinder, to light his pipe by the way. The scalps that he had taken from his enemies' heads could be trophies for nobody else, and were hung to the bridle of his horse; he was in full dress and fully equipped, and on his head waved, to the last moment, his beautiful head-dress of war-eagles' plumes. In this plight, and the last funeral honors having been performed by the 'medicine-men,' every warrior of his band painted the palm and fingers of his right hand with vermilion, which was stamped, and perfectly impressed on the milk-white sides of his devoted horse. This all done, turfs were brought and placed around the feet and legs of the horse, and gradually laid up to his sides, and at last over the back and head of the unsuspecting animal; and last of all, over the head and even the eagle plumes of its valiant rider, where altogether have smouldered and remained undisturbed to the present day (1836). This mound, which is covered with green turf and spotted with wild flowers, with its cedar post in its center, can easily be seen at the distance of fifteen miles, by the *voyageur*, and forms for him a familiar and useful land-mark. Whilst visiting this mound in company with Major Sanford, on our way up the river, I discovered in a hole made in the mound, by a 'ground-hog' or some other animal, the skull of the horse; and by a little pains also came at the skull of the chief, which I carried to the river-side and secreted till my return in my canoe, when I took it in, and brought it with me to this place, where I now have it." I have quoted this interesting account at length because it fully authenticates the building of a sepulchral mound, by nomadic savages, so late as the beginning of the present century; and also because, the horse excepted, it no doub

graphically pictures the process of mound-inhumation practiced by their ancestors from time immemorial.

The one characteristic which, it is claimed, distinguishes the mortuary customs of the mound-builders from those of the nomadic Indians is the fact that the former never buried their dead beneath the surface of the ground, but invariably placed the remains of their deceased on the ground, or in very shallow excavations and heaped the earth over them; while the latter disposed of their deceased kinsmen by placing the dead bodies either on scaffolds, in graves beneath the earth's surface, or consumed them by burning. If this distinction is admitted, we cannot fail to recognize in the burial of Black Hawk, the great Sauk chief, in 1838, a vestige of the ancient custom of his ancestors, modified by the acquisition of European ideas and arts. The old chief when dead was arrayed in full dress, wrapped in fine new blankets, with all of his trophies, ornaments and sword at his sides; then laid on a plank and placed on the surface of the ground, with his feet in a shallow excavation about a foot in depth and his head raised a foot or more above the surface. A forked post was planted at his head and another at his feet, across which was placed a ridge pole supporting split boards, or "puncheons," leaning from the ground on either side of the corpse. The gable ends of this roof-like coffin were closed with rough boards, and the whole covered with earth and sod, forming a mound about four feet high. In this instance is presented all the elements of mound burial, only wanting the tribute of a small quantity of earth from each member of the tribe in passing by, or at their annual convocations, to make it, in course of time, a tumulus similar to the most ancient in our country. The disposition of the corpse in the large mound on the Scioto, six miles below Chillicothe, described on page 162 of "Ancient Monuments of the Mississippi Valley;" and of the remains at the base of the large mound at East St. Louis, removed in 1870 to make way for a railroad track; only differ from the inhumation of Black Hawk in having been enclosed with crib-work of cedar logs instead of the ridge-pole and split boards. There is also another suggestion offered by the grave of Black Hawk which may, not inappropriately, be mentioned here. It was surrounded, to guard it from the intrusion of men and animals, with strong pickets twelve feet high, planted in the ground, with earth thrown up against them to impart additional stability, in the manner that all Indians built stockades for military defense. Had this grave remained unmolested until the wooden pickets had disappeared by decay, the small mound covering the old chief would have appeared enclosed by an earthen ring, as was the case with the great mound at Marietta, and others of that class. In this may we not trace the origin and purpose of the mysterious ring embankments encircling some of the ancient mounds?

"During the progress of this investigation," remarks Col. C. C. Jones, in summing up the result of his researches among the antiquities of the Southern Indians, "it will be perceived that mound building, which seems to have fallen into disuse prior to the dawn of the historic period, was entirely abandoned very shortly after intercourse was established between Europeans and red men. *

* * In a word, we do not concur in the opinion, so often expressed, that the mound-builders were a race distinct from and superior in art, government, and religion, to the Southern Indians of the fifteenth and sixteenth centuries." In a very able paper on the "Ancient Copper Mines of Isle Royale," by Prof. N. H. Winchell, in the *Popular Science Monthly* of last September, he forcibly says: "If we inquire further what relation the mound-builders bore to the Aborigines found here by Columbus, we shall be compelled to admit, from the evidence, that the Aborigines themselves were the mound-builders and ancient miners. * * * It is poor philosophy and poor science that resorts to hypothetical causes when those already known are sufficient to produce the known effect. The Indian is a known adequate cause. The assignment of the mounds to any other dynasty was born of that common reverence for the past and for the unexplainable, which not only unconsciously augments the actual, but revolts at the reduction of their works to the level of the red man."

To this sentiment of veneration for the past and common tendency to exaggerate the marvelous we owe the entire fabric of an imaginary semi-civilized race and mythical empire, gorgeous in semi-barbaric splendor and fascinating in wild interest as an oriental tale. It has, however, had its day and is rapidly fading away before the iconoclasm of research and common sense.

VIRGINIA, CASS CO., ILL., January 23, 1882.

THE MOUND-BUILDERS AND THE AZTECS.

Writing to the Chicago *Times* from New Mexico, Mr. S. B. Evans states that on the highest point of the great Potrero de las Vacas are some of the most remarkable prehistoric relics that have been discovered in New Mexico, being no less than the gods sculptured in stone that were worshiped by the ancients. These are statues of mountain lions, carved from a volcanic rock *in situ* that forms the cap of the potrero. The images are inclosed in a rude and almost circular stone wall, in a space fifty feet in circumference, three feet in height, with an entrance projected eighteen feet toward the southeast, three feet wide. The lions face directly toward the east, are two in number, separated by a space of twelve inches, and are each six feet in length, and represent a puma or mountain lion in the act of crouching for a spring. The heads of these statues are almost entirely destroyed, showing plainly the marks of the pious hammer that sought their overthrow. The legs, body, and tails of the animals are better preserved, and constitute the remains of the most remarkable stone images set up for pagan worship in the territory of the United States. To these gods the Cochiti Indians of the present day pay homage.

In the courtyard of the national museum in Mexico are carved images, in stone, of similar animals. Some of them are well preserved, while others bear the marks of Spanish defacement. The mountain lion was a sacred animal among

the Mexicans, as well as with the ancient and present dwellers in the mountains of Cochiti.

Opposite to and north of the potrero of the lions, in the face of a cliff and fronting a deep cañon, is a series of cliff dwellings, hewn out of the rock, in which centuries ago men made their habitations, lived, and died. All the cliff buildings which Mr. Evans has examined, face toward the south. This may be accidental. They all conform to a general style of construction. This is the result of purpose. They are superior in workmanship to the cave dwellings of Europe, and inferior to the efforts of the town-builders of New Mexico and Arizona. They are not the work of nomads, who do not stop long enough, nor do they have the disposition to hew out for themselves habitations in the rocks, but may be identified with the people who emigrated from the seven cave cities of Aztlan and found refuge in Mexico, one thousand years ago.

The antiquities of New Mexico, Colorado, and Arizona are distinct from those of any other portion of the United States, and the forms peculiar to the two last named are found in New Mexico. The object of the explorations which Mr. Evans is making, was primarily and prominently to throw light on the origin of the mysterious mound-builders, and to find, if it exists, the analogy between their works and those of the pyramid-builders in the valley of Mexico. If that analogy were established it was believed that one important step would be gained in the solution of the problem.

Beginning in Minnesota, he has by personal survey traced the mound-builders to the Gulf, and found an unbroken chain of their curious works down the valley of the Mississippi, into colonies on the principal tributaries traversing the States that border on the great stream. Mounds were found along the entire route and on the shores of the Gulf. Crossing into Mexico, the chain dropped in the sea at Galveston, was recovered near Vera Cruz. On the plain of Cholula is a mound, that, if transferred to Cahokia, would fit the landscape, and appear in keeping with the general plan of the works. On the other hand, if the great mound of Cahokia were brought in presence of Popocatapetl, it would not be abashed, but be a fit companion for the pyramid. The pyramids of the sun and moon at Teotlihuacon would be mounds in Virginia and Ohio, and the great mounds of Grove Creek and Seltzertown might embellish the ancient "City of the Gods." Excavations were made in Mexican mounds as they were made in the United States, and, substantially, the results were the same—tombs in some mounds, altars in others, and nothing in a few. Pottery was found with the lines of ornamentation the same as that discovered in Arkansas; heads of idols, the counterpart of those found in Tennessee; children's toys from each, that might have been produced from the same mould, and skulls from the tombs of San Juan with the same peculiar flattening of the occipital region that distinguishes the skulls of the mound-builders wherever they are found in the United States. The presence of an intrusive race was early detected, and the comment made that it was impossible for the Aztecs to have been the builders of the pyramids or any of the works of antiquity in that region. This, Mr. Evans

thinks he has demonstrated since, and produced absolute proofs through investigations made in New Mexico. The Aztecs were not then, or at any time, a mound-building race, and there are no mounds in New Mexico from whence they spring.

Mr. Evans concludes: "It will now be seen how necessary it was to investigate the antiquities of this territory in order to throw light on those of Mexico and the States. With the evidence all in, let us recapitulate and see what we have gained. Investigations have established the following as facts:

1. "The mounds of the United States were made by the same race that built the mounds of Mexico. Proven by close resemblance between the works; by implements used in common; similar manner of burial, and skulls from the tombs of each locality.

2. "The mounds of Mexico antedate Aztec occupation. Proven by records that the Aztecs did not enter the valley until the close of the thirteenth century; by investigation that the mounds contain skulls that are not Aztec; that they contain specimens of the plastic art that could not have come from the hand of an Aztec.

3. "The Aztecs were not a mound-building race. Proven by investigation in New Mexico, disclosing the fact that there are no temple, sacrificial, or burial mounds in the land from which they come; that they build no mounds here, and built none in Mexico from the time the Spaniards occupied the country in 1520 until the present, and it was a physical impossibility, even though they had the knowledge, to have erected all the mounds and pyramids in Mexico during the space of time that elapsed from their entry into the valley until its occupation by the Spaniards."—*Scientific American.*

GEOLOGY.

THE CHERT ROCKS OF SUB-CARBONIFEROUS KANSAS.

BY ERASMUS HAWORTH, B. S.

The Keokuk group of the sub-carboniferous in Southeastern Kansas, presents many interesting phenomena. According to Prof. Mudge, the stream known as Spring River marks the northwestern boundary of this group. This, I think, is not exactly correct. In some places on the west side of the river, the formations appear to be the same as those on the east. In this Keokuk group occur the lead and zinc deposits of Short Creek and, farther east in Missouri, those of Joplin City, Oronogo, Webb City and other places of less notoriety.

The occurrence of lead and zinc ores in this vicinity has been so frequently discussed, that perhaps nothing new could be said on the subject. But the pecu-

liar occurrence of the chert beds, which are everywhere quite common, is almost as interesting to the scientist, although they will never call together thousands of people, or transform the poor disheartened prospector into a millionaire.

The chert formations occur at different depths, as deep as shafts have been sunk, alternating with limestone. In some places there seems to be but little regularity to the deposits, while in others they lie one above the other, the irregularities of the one closely fitting those of the other. A high bluff on the right bank of Shawnee creek, about half a mile above where it enters Spring River, affords a view of these alternations. This bluff is from 80 to 100 feet high, and is very abrupt, making an angle of about 75° with the horizontal. Here the layers of limestone and chert alternate with great regularity, the layers of each varying from only a few inches in thickness to as much as three feet.

In some places there seems to be no opening or crevice between the two kinds of rock, but they are firmly held together so that when the rocks are broken in pieces, fragments may be obtained, consisting partly of limestone and partly of flint. Cart loads of such specimens could be picked up along the foot of the bluff.

On the left bank of Spring River at the little town of Lowell, is another high bluff, which affords excellent opportunities for studying the formations. Here also are limestone and chert formations alternating with each other. The layers of chert are not continuous as they are at Shawnee Creek bluff. A layer at one place may be six inches thick and at a short distance in either direction entirely disappear, thus presenting somewhat the shape of a very large thin disc.

Throughout this whole region may be found cherty concretions, having in general the shape of a prolate spheroid, the major axis of which is twice that of its minor. These differ greatly in size. Some of them are so small that the major axis does not exceed three inches, while in others it is fully twenty inches long. These concretions are generally solid throughout; occasionally, however, one is found with a small, narrow cavity at the centre, parallel with its major axis. As far as I have observed, these cavities are never lined with crystals. A transverse section of the concretions shows concentric circular bands, intimating that their formation was symmetrical with reference to their major axis. The miners call them "mineral eggs." I have noticed them in greatest abundance on the west side of the river. On the right bank of Shawnee creek, half a mile above the high bluff before referred to, in connection with other cherty rocks, they occur fully fifteen feet above the highest limestone horizon. (It might properly be stated that north and west of the sub-carboniferous is a great sandstone formation, the limits of which I cannot give, but I think it is bounded on the west by Neosho River and extends some thirty miles north). In a few instances, these concretions have been found imbedded in limestone which fit closely around them. These chert rocks are filled with fossils, which are so numerous that it is doubtful whether, from the shells alone, a limestone could be distinguished from a chert rock. In fact, almost every fragment that is picked up, is filled with fossils, whether it comes from the hill side or from the gravel

beds of the streams. Crinoids seem to be the most abundant, but many other types are represented. The shells of the crinoids are rarely present, but the cavities from which they have been removed so perfectly represent their outlines that their forms are plainly shown. There is, however, quite frequently a central stem of silica corresponding to the central cavity of the crinoid stem. They have been so numerous that it is easy to find blocks of chert that will not weigh more than half as much as an equivalent volume of solid chert. Specimens are sometimes found which show that a portion of the rock was formed without including shells, while the other portion of the same specimen was literally filled with them.

In some places the chert presents quite a tufaceous appearance. This is best represented at the Short Creek mines, although it is by no means confined to that locality, many similar specimens having been found on the west side of the river. At Short Creek hundreds of tons of this partly decomposed chert have been lifted from the mines. In many cases the outlines of the fossils are still easily detected. Also it is not uncommon to find inclosed crystals of sphalerite (zinc blende), or cavities from which such crystals have been dissolved. It was an easy matter to select a series of specimens, showing all the variations, from those in which the crystals were almost perfect to those from which they had been entirely removed.

In such a series, it is to be noted that the decomposition of the rock itself corresponds almost exactly with that of the sphalerite crystals; that is, the rocks which contain the most perfect crystals are the least decomposed, while those from which the crystals have been entirely removed, have suffered the greatest decomposition.

Another peculiarity of the chert is the fact that it has innumerable fractures running in every direction. In some places they are quite a distance apart, in others they are very close together. In some places great masses of it seem to have been broken into millions of fragments without any of them being removed; in other places the angular fragments seem to have been partially removed and subsequently formed into conglomerates by the cementing action of calcite, dolomite, iron oxide or zinc blende.

For two reasons I have thus detailed facts which can be observed by all. First, it is thought that Southeastern Kansas is not only the most intricate, geologically, but also the most interesting of any part of the State. Second, the facts mentioned may have a bearing on theoretical geology.

Three hypotheses have been offered to explain these phenomena. First, all of the rocks except the conglomerates were originally limestone. In the course of time waters charged with silica, or a silicate, metamorphosed portions of the limestone, leaving them in their present condition. Previous to this action, cavities had been worn in the limestone in which the silica-laden waters deposited silica, forming the concretions. In some places the limestone has been subsequently removed, leaving the concretions free; in other places they have been

held *in situ*. Second, the silica was present from the first formation of the rocks, having been collected by *Polycystines*, *Diatoms*, the spicules of *Sponges*, etc. Third, the silica was present from the first formation of the rocks, but was deposited by physical and chemical means, rather than by the intervention of life.

The first hypothesis is objectionable because it seems inadequate. It is difficult to conceive of conditions under which great strata of limestone could be completely silicified without altering those in direct contact with them. It is true, the purest limestone in this locality contains silica; some specimens may be found containing a large per cent. of it, but there is no trouble whatever in distinguishing the limestone from the chert. In other words, so far as has been observed, there is positively no gradation of the one into the other, as would necessarily be the case had the above mentioned metamorphic action taken place. The occurrence of the concretions and the chert so far above the limestone horizon, would be impossible by this theory, unless we conclude that here the change from the limestone to the chert was complete. But it is hardly possible that the transformation act would have been so complete here and so incomplete in other places. Again, the condition of the fossil crinoids has a testimony of value. Had they been imbedded in limestone, it is hardly probable that the limestone itself would have been completely changed to the most compact chert without the same action affecting them sensibly. If we assume, however, that the body of the rock was chert when it was first formed, we can easily see how the central cavity of the crinoid stem would be filled with silica, and how the body of the stem itself, long after the rock had become a compact mass of flint, could be removed by the solvent action of water, the most solid rock being penetrated by water. The fact that in the same mass of chert one portion has been filled with crinoids, and the other portion has contained none, may also throw light upon the subject. It is quite possible for a mass of silicic acid, were it present in sufficient quantity, to settle to the bottom of the water in which it was suspended, completely cover up and enclose within its mass all the shells which were present, so that the lower portion of the rock thus formed would be filled with shells, while the upper portion would be free from them. If, then, there is any action between silicic acid and calcium carbonate, some of the shells would be silicified. The facts observed exactly correspond to such an hypothesis.

It is well known that waters charged with silicic acid do affect limestone and calcareous shells. Prof. Patrick* of Kansas State University, has shown that such an action has taken place at the Great Spirit Spring, near Cawker City, Kan. Church† had occasion to investigate this subject in his researches with reference to the origin of beekite, a peculiarly mineralized fossil quite common in some parts of England, He passed water containing carbonic oxide and silicic acid in solution, through a piece of coral fitted into the neck of a funnel. The porosity of the coral permitted the water slowly to pass through. Almost the whole of the silica was deposited on the coral in a jelly like mass, while a cor-

*Trans. Kan. Acad. Sci. Vol. 7, P. 22.
†L.. E. & D. Phil. Mag. (4) Vol. 23, P. 95.

responding amount of calcium carbonate was removed. Dr. T. Sterry Hunt* has held that the numerous silicified shells have thus been changed before they were enclosed in the limestone which surrounds them. He describes shells which are only partly silicified, the central portion being unchanged.

The second hypothesis mentioned is understood to be the generally accepted view. It may fairly be represented by quoting from pages 615 and 691 of Dana's Manual of Geology, 1876: "The silica in most siliceous petrifactions, has come from siliceous organisms associated with the fossil in the original deposit;" and: "The geological effects of silica in *cold* solutions appear to be of only infinitesimal importance." There can be no doubt that the spicules of *Sponges* and the shells of *Diatoms* and *Polycystines*, have contributed largely to the silica of the earth's crust. The flint nodules of chalk seem to be almost entirely composed of them. Throughout the whole stratified crust of the earth, we find sandstone and chert formations in great abundance. The sub-carboniferous of Missouri, Tennessee, Kentucky, Iowa, Illinois, Indiana, and in general wherever it occurs, presents phenomena similar in many respects to those observed in Kansas. Fossils imbedded in chert are common to all the above mentioned States. In fully one-third of the State of Tennessee the sub-carboniferous is exposed, the lower portion of which has been named the "Siliceous Group."‡ Portions of the sandstones are fragmental rocks, which may be traced to granitic and other forms of siliceous rocks. But we can go no farther. We cannot say how the silica came in those rocks, but we have every reason to believe that life had no part in their formation. Other portions of sandstone show, from the perfect crystalline form of their grains, that they are *not fragmental*, but that the silica has been deposited in some manner that favored crystallization, so that organisms are shut out from these. Daubree§ has shown that by the mechanical decomposition of ancient rocks, the proportion of silica left in the form of sand, would be entirely too small for the formation of all the great beds of sandstone; also that in different parts of France a large per cent. of the sandstone is composed of crystallized grains. Mr. J. Brainard, at the meeting of the American Association for the Advancement of Science in 1860, called attention to certain sandstone in Ohio of crystalline origin.

It is well known that natural waters frequently hold silica in solution. Deville‖ has said that silica was found in *all* the natural waters which he has examined. M. Ebelman¶, by a careful and exhaustive analysis of basaltic and similar rocks in different degrees of decomposition, has found that the amount of silica rendered soluble by decomposition is as great, in some instances, as 57 per per cent. of the original amount. He compared the alumina with the silica before and after decomposition, and found that in some specimens in which for

*Canadian Naturalist, New Series, Vol. 1, P. 46.
‡Safford's Geol. Sur. of Ten.
§Annals Des Mines (5) Vol. 12, P. 535.
‖Annals de Chemie et de Physiq ie. Vol. 23, p. 33.
¶Annals des Mines (4). Vol. 6, p. 31.

100 parts of alumina there were 347.5 parts of silica before decomposition, the proportion in the resulting clay is only 100 : 118.3.

When we consider the vast amount of silica that has thus been carried to the sea, we are forced to conclude that it must have been deposited by some other means than that of life. The amount is too great to be referred to so small a number of microscopic organisms. Even if we did not have the positive evidence in the crystallized grains of sandstone, we could draw such a conclusion; but when we have this we may reasonably conclude that *other* portions have also been deposited without such assistance. The question then arises, what is there to indicate that the greater part of the silica in the *petrified* remains of organisms is derived from animals and plants that secrete siliceous matter? In all cases where true petrifaction has taken place the silica must have been in solution, and if the spicules of Sponges, etc., are once dissolved, the silica simply takes its place with other portions that are held in solution and can no longer be looked upon as of organic origin. The extraordinary occurrence of chert beds in the sub-carboniferous may be due to the fact that it succeeded an age when the conditions were most favorable for the rapid decomposition of ancient crystalline rocks. The air was probably much richer in carbonic oxide than at present, and there was a larger surface of metamorphic and crystalline rocks exposed than has been at any subsequent time; because, as the decomposition continued, portions of the surface once exposed would be protected from the atmosphere by the clays and soils formed, and the new formations that subsequently emerged contain but few rocks that would yield silica by the action of decomposing agents. There was the great V-shaped ridge on the north which extended as far south as Pennsylvania and also included a large portion of Ohio. A ridge extended down the Alleghenies as far as South Carolina. There was also a large tract in Missouri, including the greater portion of the Ozark Mountains. The great central basin of the Mississippi Valley was thus almost entirely surrounded by hills of decomposing rocks, the silica of which was being poured into its waters. Everything was thus favorable for a *maximum* formation of siliceous strata. If the decomposition of these ancient rocks was as rapid as we have reason to suspect, the proportion of silica which the ocean waters contained was much greater than at the present time. Graham* has shown that when pure silica is held in solution, $\frac{1}{10000}$ part of an alkali or alkali earth carbonate precipitates it. At the present time the greater portion of silica is held in solution by an alkali that is an alkaline silicate. But this is not necessarily so. In the article above referred to, Ebelman has shown that an alkali is not essential. The following are his words: "The researches which I have described have shown that the silicates without alkalies are decomposed as easily as the feldspathic species, sometimes even before them, and that the removal of the silica is, in certain cases, more complete than from [in] kaoline. The separation of silica may, therefore, be entirely independent of alkalies."

* Philosophical Magazine (4). Vol. 23, p. 296.

It seems but reasonable, then, that large portions of silica were precipitated as gelatinous silicic acid which gradually settled to the bottom and formed great chert layers. There would not be pure silica unless the waters were free from impurities, neither would the limestone formed be free from flint unless the waters were periodically *entirely* free from silica. Let us recall the condition in which these rocks are now found in southeastern Kansas. The regular stratification in places alternating with limestone which was forming at the same geological time, just as it should be. Also the presence of fossils would be expected, some of them being silicified, others resisting this action, to be subsequently removed by waters charged with carbonic oxide.

The concretionary formations with their banded structure might also have been expected; and finally the irregular deposits which have been called "disc shaped" would certainly be formed where there was not enough silica to form continuous layers. As far as observed, everything seems to be just as one would expect. The writer looks upon the peculiar formations described as evidences which may be added to that of the sandstones composed of crystallized grains. The amount of silica included in the chert and sandstone beds of different eras is so great that anything short of direct precipitation and crystallization from saturated solutions, seems to him intirely inadequate as a cause.

The tufaceous appearance of some of the rocks is evidently due to the solvent power of water. Dr. Schmidt, of St. Louis,* thinks that these are of much more recent formation than the others; that the limestone was first dissolved and the cavities filled with porous chert. This view is inconsistent with the occurrence of fossils in these rocks. If the limestone had been dissolved out, the fossils would have been destroyed, so that the subsequent formations in the cavities thus produced would have been entirely barren of fossils. They also contain zinc crystals as occasionally do the undecomposed rocks, which would further indicate that they were of the same age.

What already has been said will show that these rocks cannot be of volcanic origin, as has been held by Prof. Hay, of Chetopa, Kansas. The occurrence of fossils alone is sufficient to disprove this theory, but the additional evidence of the enclosed crystals place it beyond all doubt. If we consider the great range of temperature between the fusing points of zinc sulphide and silica, it is seen at once that the idea of the two having cooled from a molten mass is entirely unreasonable. The fractures in the chert beds remain unexplained. Dr. Schmidt, as above referred to, attributes them to the contraction caused by the dolomitization of the limestone and the dislocations caused by the dissolving out of the limestone in places. This view is objectionable for two reasons. First, the decline of the old theory that pure limestone is dolomitized on a grand scale. With our present knowledge of the chemical properties of the salts of calcium and magnesium it seems much more reasonable that the magnesium now present in the great beds of limestone in the Mississippi Valley was enclosed in their formation. Second, if the old theory be true, the assigned cause is entirely insufficient.

* Trans. St. Louis Acad. Sci., Vol. 3, No. 2 p. 246.

XUM

The contraction of the limestone, however great, could not cause those fine fractures so common in many places. Neither could it fracture the rocks at so great a distance from the limestone as has been done. I have often seen rocks heated to a moderately high temperature and plunged into water. The sudden cooling would cause them to crack in every direction, but their fractures would be no more irregular or complicated than those of the chert rocks above alluded to. The idea of their having been heated is entirely untenable, however: the fossils in the limestones would contradict such views. They remain thus far unexplained.

THE FORMATION OF COAL.

All attempts to explain satisfactorily the formation of coal have thus far proved unsuccessful, though it is generally understood that it is the product of the decomposition of vegetable matter. Just how that decomposition has been brought about chemically is a matter which chemists have not as yet been able to solve. The principal difficulty has been that it has been impossible to obtain a clear insight into the chemical constitution of coal. It has been thought hitherto, and this is still the popular belief, that coal is in the main pure carbon, mixed with varying quantities of bituminous substances. It has been generally believed, that, as the product of the distillation of coal is principally carbon, it would be safe to conclude that free carbon actually does exist in coal. The fact that sugar, starch, etc., under similar circumstances, leave a residuum consisting of carbon, has never been considered a proof that that element existed in these bodies in a free state. It is well known that coals which may have the same percentage of carbon, hydrogen and oxygen do not by any means, in coking, yield the same products of distillation, and we have a complete analogy for this in the behavior of cellulose and starch when subjected to distillation. Evidence points to the conclusion that coal is a mixture of many and complex compounds; and the difficulty, amounting to almost an impossibility, of separating these compounds, has much to do in rendering a chemical solution of the questions involved in the formation of coal a very arduous task. The production of coal by artificial means is met by great obstacles, among which the absence of all knowledge concerning the conditions under which that process actually took place is the principal one. The question whether the vegetable matter to which our coal veins owe their origin was amassed by drifting or was carbonized *in situ*, has been much debated, and there has been much discussion on the point whether it was obtained from water or from land plants.

Dr. Muck, of Bochum, in a recent work, takes up the theory that algæ have mainly contributed to the formation of coal. It is urged that the remains of marine plants are rarely found in coal veins, and that shells, etc., are not often met with. Dr. Muck calls attention to the fact that marine plants decompose easily and completely, losing their form entirely; and that the disappearance of

the calcareous remains of molluscs is readily explained by the formation of large quantities of carbonic acid gas during the process of carbonization. In accepting the marine origin of coal it is not necessary to resort to the assumption of immense pressure and high temperatures to explain decomposition and the total destruction of the structure of the original substance. Dr. Muck combats Frémy's bog theory at length. His views are well supported by recent investigations made by Herr P. F. Reinsch, who has examined 1,200 sections of coal, coming to the conclusion that that mineral substance has not been formed by the alteration of accumulated land plants. Herr Reinsch claims to have discovered that coal consists of microscopical organic forms of a low order of protoplasm; and though he carefully examined the cells and other remains of plants of a higher order, he computed that they have contributed only a fraction of the matter of the coal veins, however numerous they may be in some instances.—*Journal of Applied Chemistry.*

GEOGRAPHY.

(*Translated from l' Exploration, December* 15, 1881, *by E. L. Berthoud.*)

ASIA.

FROM THE FRENCH OF SEVERTSOF.

THE PAMIR OR ROOF OF THE WORLD.—Mr. Severtsof, an eminent Russian explorer, has ascertained that the "Pamir" is not a plateau in the absolute sense of that word.

It is traversed by rivers flowing at an altitude of 14,000 feet in valleys nowhere exceeding thirteen miles in width. This same peculiarity is also noticed in the Tien Chan Mountains, and in Thibet, where we find narrow valleys or enormous elevations.

In the "Pamir" there is no table land where we find mountains 6,000, or 7,000 feet high above the level of these valleys. The orographic system of the Pamir includes numerous peaks which attain an elevation of 19,000 feet, and three groups of mountains which reach an elevation of 25,000 feet above sea level.

THE RUSSIANS IN KASHGAR.—A commercial caravan conducted by Mr. Dalgleish, a Russian merchant, reached Yarkand on the 8th of September, 1881.

The caravan has been cordially received by the Governor of Kashgar, who gave to Mr. Dalgleish authority to reside in the city and sell his merchanise in all the province of Kashgar.

XUM

AFRICA.

EXPLORATIONS OF THE ZAMBESI.——Mr. Guyot, a French explorer, has been exploring the Zambesi and its affluents. September 10, 1881, he reached Tetts, a Portuguese settlement.

His exploration has been in part on the river Muareze, an affluent of the left bank of the Zambesi. This river has appeared on the map of St. Jvao Montero de Foureca Vatz, as the Uamiteuze, a name unknown to the natives. He finds on the Muareze a carboniferous formation with its schiests and its sandstones and huge masses of diorite, of such magnitude that the shores and bluffs were wholly composed of it.

On leaving the Zambesi he found a number of villages where he obtained provisions and hospitable treatment by distributing some cotton cloth.

The strata of coal found in the bed of the Muareze are thin sheets intercalated in strata of schists, which alter its quality very perceptibly.

At twelve miles distance from the Zambesi roads are difficult, and safety very uncertainty. The whole country is infested by Bonja, who are brigands; Mr. Guyot escaped attack solely on account of his escort of fifty Sepoys.

The health of the expedition is excellent, and some of the party have started for Manico.

We have lately announced the happy return from Timbo, in western Africa, of Mr. V. Gaboriand, who was intrusted by Mr. Aime Olivier with the mission of obtaining from the Almany of Foota Djalloo, a confirmation of the treaty of friendship and the concession of a railway, already accepted and signed between Mr. Aime Olivier and the Almany Javery, the predecessor of Ahmadon the present ruler.

The Commercial Geographical Society of Paris has received on this subject new particulars as follows: Mr. Gaboriand brought back with him a copy written in Arabic, signed by Ahmadon, countersigned by his heir and properly certified to by their interpreter, of a treaty signed on the 10th day of July, at Timbo, between Mr. Gaboriand and the above named chief.

The terms of this treaty are as follows: Almany Ahmadon authorizes the construction of a railway, which is to end on the west coast, and concedes to the R. R. Co. the necessary lands for its construction.

He also agrees to furnish all the laborers necessary for its construction, and to protect the construction and maintenance of this enterprise; granting also to Mr. A. Olivier the right to establish in his government, free from tax or any assessment, factories or commercial trading houses.

"All aboard for Timbuctoo," will soon be as well known as any other railway tour: for the construction of this road to Timbo from the Senegal is a vast step forward into Central Africa.

RUSSIAN EXPEDITION TO THE BAY OF OBI.

Colonel Veninkoff has written some details on the Russian Expedition sent in the spring of 1881, under the direction of Colonel Moisseef, to the Bay of Obi.

The explorers have followed the eastern shore of the Bay between the 67° and 72° latitude, and by their astronomical observations have demonstrated the fact that on our maps we must move the coast from 20 to 25 kilometers more to the west. On the other hand the Bay of Obi being reduced in width, the peninsula between the Obi and the Taze is largely increased in width.

At the mouth of the Lena a meteorological and magnetic station is to be established. As we have before stated, the expedition charged with this work has just started from St. Petersburg. The Russian Geographical Society which has taken the initiative in concert with all other scientific institutions that are instructed with the realization of the project of Comte Wilezek.

The observer selected for this station is a young man, Mr. Yurgens; who to reach his destination, will have to travel 3,000 kilometers in a sleigh, then 3,000 kilometers in a bark or in canoes.

He is to return at the end of one year. We will thus have an uninterrupted set of observations regularly taken and maintained in a circumpolar station, which is something of which there is almost a total want.

OPTICS.

"CONTINUOUS IMAGES OF LIGHTNING."

BY PROFESSOR FRANCIS E. NIPHER.

The phenomena described by Mr. Blair in the February number of the REVIEW is one which can be reproduced at any time by looking at any bright object, like a gas flame or even a candle. The explanation is correctly referred by the editor to a residual effect upon the retina.

If a gas flame is observed by fixing the eye steadily for a few seconds upon some point *near* the flame, and if the eye is then closed or turned quickly to a darker part of the room, an after image of the flame will be observed. This effect lasts but a short time and requires careful observation in order to see it unless the object viewed be bright. Nevertheless, the part of the retina upon which the image of the flame was formed is still in a different condition from the rest of the retina, and this may be seen by turning toward the flame again, so that the light will again enter the eye, at the same time opening and closing the eyes rapidly. The after image will again come out in a most vivid manner, and can be seen for several minutes. This reproduces the same conditions under which Mr.

Blair observed the after images of lightning flashes. This experiment can be made in a most striking manner by means of the sun. Observe for a few seconds some point on the sky, say ten to thirty degrees from the sun, then move the eyes quickly to some other point, again holding the eyes still for a few seconds, and repeat the operation for ten or fifteen points around the sun. Then turn partially around, looking at the blue sky or at a bright cloud, and you will observe the after images as usually described. But if you open and close the eyes rapidly, the after images come out with astonishing distinctness. The field of vision will be filled with images of the sun connected by lines which indicate the paths traced by the solar image in passing from one position to the other upon the retina. The color of the images, also, is very marked, and goes through various changes which depend upon the nature and intensity of the light, upon the brightness of the sky which is observed, and probably upon the observer. These images appear to have a motion in the field of view, but this is merely the motion of the eyes, and the experiment will serve to indicate to the observer how difficult it is to keep the eyes still.

A partial explanation of the phenomena it is not difficult to give. If any brilliant color, (say a bright cloud through a red glass, or a red paper well illuminated by diffuse light,) be observed for some time, the sensation of color becomes gradually feebler. Ordinarily this is not noticed, but by closing one eye and observing with the other it will be brought out very distinctly if the eyes are after a time alternately opened and closed. The red will appear much deeper to the eye which has not been fatigued for red. To an eye fatigued for red a white paper would appear as though red had been stricken out, *i. e.*, it would appear greenish, while a green color would appear more intense. The same holds for the other colors. The part of the retina upon which the image of the sun fell was fatigued for *all* colors, and hence the after image on a bright ground appears dark at first. The fatigued part of the retina gradually recovers its sensitiveness, and appears to recover more quickly for some colors than for others; the color of the after image at any moment being thus the combination of the colors for which that part of the retina has at the moment become sensitive.

Two works recently published in the "International Scientific Series," will be found exceedingly interesting and instructive in the study of such phenomena, *viz.*, "Modern Chromatics," by Rood, and "Sight," by Le Conte. Both works are admirable, not only in describing many experiments which any one can make for himself, but in presenting clearly and in a simple manner the general principles which enable one to explain similar phenomena. As the eye is the one optical instrument which we all possess, it is certainly natural that we should all feel an interest in the study of its action and its peculiarities.

XUM

CONCHOLOGY.

NOTES ON DISTRIBUTION OF SHELLS.—NO. II.

BY F. A. SAMPSON, FT. WORTH, TEXAS.

The present mild winter doubtless gave a better opportunity for finding living shells at Ft. Worth, than would often occur at New Year, but with butterflies and moths flying, one would naturally expect to find shells still crawling or lightly covered. The country around is generally prairie, but along the Trinity river and other streams, there is more or less bottom land of post-pliocene formation, and bordering these streams are bluffs more or less rocky, and in places about one hundred feet in height, the rock exposures and the prairies all being of the cretaceous period.

Of the shells found by me around the town, and on trips in two directions about ten miles each, I make the following notes:

1 *Mesodon roëmeri* Pfr. Found at all stations near timber, both on the bluffs and in the bottoms in considerable numbers, and bunched together as if for the purpose of imparting warmth to each other. Under one small log in the Trinity bottom I obtained over fifty mature live specimens. I could detect no difference in those found on the bluffs from those on the lower grounds, but the shells all differ considerably from the same species at New Braunfels, Texas, being larger in size, of deeper color, and uniformly open umbilicus. I found a single albino.

2. *Polygyra texasiana*, Moricand, was quite plenty in places in the river bottom, under stones, logs and in the ground where brush and leaves were lying. Binney in his Land Shells of North America, gives the size of this species as 10 mm., and says that there is a larger size with a brown band above the periphery. The specimens here, however, are from 8 to 10 mm. and all have the brown band more or less distinct. Through the shell the animal shows irregular black spots, the last whirl having a line of them, sometimes continuous, running diagonally through nearly one revolution. In some the spots are quite large and in others small. The eye peduncles are deep black, and from their bases are two bands of black down the neck and body, the remaining parts being a uniform light color.

3. *Polygyra mooreana*, W. G. Binney, was not plenty, principally on the bluffs. Less than half the shells were white, but those of horn color appeared to differ in no respect except in the color of the shell. The spots showing through the shell were not so large or so black as in the last species. The head, neck and body were a uniform dark brown, and the eye peduncles still darker. Al

specimens were uniformly of five and one-half whirls, while *P. texasiana* varied from five to five and one-half.

4. Polygyra dorfenilliana, Lea. But a single specimen was found. At Denison it is common, and the other two here found of the same sub-genus are not found there.

5. Helicina orbiculata, Say, was apparently as much at home on the bluffs as on the bottoms. From one to three inches in the ground under leaves and brush, and in some cases under logs and stones, they were found hibernating. The shells were larger than those from Denison or Houston, but there were fewer colored shells than at the former place.

6. Bulimulus alternatus, Say, or that variety which has been described as a separate species under the name of B. Schiedeanus, Pfr., and its variety *mooreanus*, W. G. Binney, were found at all places with the last. A few were under logs, either adhering to them, or buried in the soil beneath, but they were more plenty under leaves and brush, lying almost at the surface of the ground with the opening upwards. The two last species were very plenty, and they with *M. roëmeri*, *P. texasiana* and various species of *Unios* were found fossil in the post-pliocene formation.

7. Strobila labyrinthica, Say.

8. Hyalina minuscula, Binney.

9. Pupa fallax, Say.

10. Pupa contracta, Say.

11. Pupa rupicola, Say.

These five specimens were found very sparingly in the river bottom. Of *P. fallax*, I obtained but a single specimen, and that a dead one.

12. Hyalina indentata, Say, was found in small numbers with the latter, and also on the bluffs. They were six mm. in diameter.

13. Succinea grosvenorii, Lea, were obtained in considerable numbers around a pond and at other damp places, under sticks or weeds, and in some cases crawling around.

The search for land shells was pretty thorough, and the absence of even dead shells of any other species, shows that the list would not be much extended by both summer and winter collecting.

In the case of fresh water shells the search was not as satisfactory or complete. *Lymnæa* and *Physa* were still active; though I found dead *Planorbis* in various places. I did not get any living ones.

14. Planorbis trivolois, Say.

15. Planorbis parvus, Say.

16. Sphærium partumeium, Say,

These three were found in one pond, but were all dead.

17. A few miles from the town on the edge of the prairie, I noticed a small stream of water coming from a spring, and on examination I found a small globose *Lymnæa* of about five whirls, and only four mm. in length. From the number of whirls and the solidity of the shell, I took it to be a mature one, but a few

rods further up, in the spring, were shells twelve mm. in length and six and one-half to seven whirls, and these were probably the mature shells of the same species. In other streams the shells were more globose, the suture more impressed, of one whirl less and two mm. less in length.

18. Of the *Physas* there seemed to be three varieties, though they would all, perhaps, be considered as *Physa Neterostrophe*, Say. One of about the typical shape is only nine mm. in length, with six whorls. The second is fourteen mm. in length with seven whirls. The third, while as wide as the last, is two or three mm. shorter, and nearly one whorl less. It has considerable resemblance to *Physa ancillaria*, Say. All three of these varieties are very fragile.

There are doubtless several other water shells in addition to the *Unios*. I found several species of the latter, but my opportunities were not sufficient to attempt making a list of what may be found.

The difference between the shells found here and at points only a hundred miles away, is very great. I have found various species at Denison which are not found here, and some that are plenty here do not extend to that part of the State. The conchology of our country cannot be properly understood until specimens and facts are gathered from every hundred miles, or even shorter distances. When that is done, theories can be given and conclusions reached without so much of guess-work or imagination as now.

ASTRONOMY.

THE SAROS AND THE TOTAL ECLIPSE OF 1806.

BY WM. DAWSON, SPICELAND, IND.

Having lately found much interest and practical value in the use of the Saros, I thought perhaps other tyros of astronomy might also find entertainment in some instruction on this point. Possibly some readers of the REVIEW may not know what I mean by Saros. It is the Chaldean Period of 18.03 years, after which eclipses of the sun and moon recur in nearly the same order and kind as they were before. That is, you take the time of an eclipse—say June 11, 1881, at midnight or 12h., and add 18.03 years, you get the time, very nearly, of another eclipse of the same kind, and this addition may be carried on for ages in the future without missing the time of recurrence of an eclipse more than a few hours—half a day at most. And all eclipses that we ever have of both sun and moon, recur or have occurred in the same way and order in this respect. This period is believed to have been found out by the ancient Chaldeans and used by them in predicting eclipses. True, it does not show the time of any individual eclipse to a minute or second, as the adept mathematician obtains by long and

tedious processes of calculation. But it is easy to learn and quick to use; and what tyro in this line would not be truly gratified, after half a minute's calculation, with ascertaining by his own work the nearest hour or so when an eclipse, 18.36 and so on years in the future, will take place. He may find also when they have occurred in the past. An almanac for any year will give a starting point in the matter, for there is no year without two eclipses. There are generally four; occasionally six, and never more than seven in one year.

If you have taken the pains to gather up the almanacs for eighteen consecutive years, or in some other way have obtained a catalogue of all the eclipses that occurred in this period, then you have the times at which seventy of these interesting phenomena of the heavens took place—forty-one of the sun and twenty nine of the moon. This would afford quite a basis for operation.

I presume that most, if not all, readers of the REVIEW understand what eclipses are, and what causes them; that an eclipse of the sun must occur at new moon and an eclipse of moon at full moon. In passing we will glance at the nodes and lunations. You know that the moon's orbit, or path, is slightly inclined to the earth's orbit, which is the sun's apparent path. This angle of inclination is 5° 8′. Now the points where these orbits intersect, or cross each other, are called nodes. And that one where the moon crosses the sun's path from north to south is the descending node, and the point of moon's crossing from south to north of the ecliptic is the ascending node. They are on opposite sides of the earth, and a line joining them and passing through the earth is called the line of nodes. Now these nodes are not stationary, but *move backward, or to the west,* on the ecliptic (earth's orbit) at the rate of 19⅓° in a year. So that the sun, after passing one node, comes round and meets the same node again about twenty days less than one year, or in 346⅝ days; and we will call this a node-year. Then nineteen node years will contain 6,585.78 days.

A lunation is the time from one new moon to another, the mean length of which is twenty-nine days, twelve hours, forty-four minutes, three seconds. Now 223 of these lunations are equal to 6585.32 days, a period of time very nearly equal to the nineteen node-years. And here we get the Saros; which in years, days, etc., is eighteen years, about eleven days, seven hours and forty-three minutes. I say *about* eleven days, and there is rather a critical point here which must be observed. When four leap-years come in the Saros, we use eleven days; but there are frequently five leap-years in the Saros, when but ten days can be used with the eighteen years. And at the close and beginning of centuries which do not contain 400 without a remainder, sometimes only three leap-years occur in the Chaldean period, and then we must count in twelve days. But the seven hours and forty-three minutes must be used in all cases.

It may be noted that the difference between nineteen node-years and 223 lunations is 0.45 of a day, or nearly eleven hours; and in this time the sun moves 28′ of arc to or from the node, as the case may be. Note, also, that if the sun and moon are in the line of nodes at the middle of the eclipse, the eclipse will be central on the earth's equator. Then at the next eclipse, when 18.03 years have

passed, the sun will be 28′ from the node to the west; and if it is at the descending node, the eclipse will be north of the equator; for the sun, as it were, has fallen back of the node; that is, the 223 lunations are completed and the eclipse occurs before the sun, in his annual course, has got to the node—while he is yet 28′ back or west of it; and the moon is a little north of the plane of the earth's orbit, which throws its shadow, or the central eclipse, somewhat north of the earth's equator. At the end of the next Saros the sun is another 28′ (now nearly a whole degree) back of the node, and the moon's latitude is a little greater, and the eclipse must be still farther north than the other one was. Now the sun's distance from the node being nearly half of a degree greater for every Saros, and the moon's latitude (distance from the plane of ecliptic, or earth's orbit) near 3′ more, it follows, that, in the course of time, the sun will be so far from the node and the moon's latitude so great that her shadow and the eclipse will be thrown entirely off, and miss the earth at the north pole. And this occurs when the sun is about 18° from the node and the moon's latitude of 1° 33′, which is the extreme limit from the node that an eclipse can take place, on account of the moon's orbit separating from the ecliptic plane. Then no more eclipses of this series could strike the earth until the sun had made near the entire circuit of the moon's orbit; that is, to the extreme of eclipse limit on the other side of the same node. And to go this round would require about 12,000 years. Then the penumbra of the moon's shadow would begin to touch the earth again at the south pole, and another series of Chaldean periods of eclipses would begin their spiral rounds, or eighteen-year visits to the earth, moving northward at each return, by reason of the sun still approaching the node and the moon's latitude getting less and less until about thirty-six periods have come around, when the sun will again be very near the descending node for this series; the moon (at new, or "change") be nearly or quite in the ecliptic plane, and her shadow—the eclipse—midway between the poles; then northward as before. But the eclipses at the moon's ascending node first touch the earth at the north pole, and work southward till they finally wear off and leave the earth at the south pole. Now there being more than seventy—well toward eighty—periodical returns of an eclipse during its passage from pole to pole (nearly 8,000 miles), we see that, on an average, each eclipse is about 100 miles farther north or south than the preceding one; and so it is with all the sixty-one solar eclipses that occur during the eighteen years. And so each of the twenty-nine eclipses of the moon that occur in the same time is at first very small, but grows larger (the moon being more deeply immersed in the earth's shadow) at each return, becoming total about the thirteenth return, and continuing so for twenty-two or twenty-three Saroses; then partial again and growing less and less—but on the opposite side of the earth's shadow—until thirteen more Saroses have returned; after which the moon will miss the earth's shadow; and that series of eclipses be no more visible to earth for many centuries. We thus perceive that the Chaldean series of lunar eclipses continues only about forty-eight periods, or 865 years; whereas the periodic series of solar eclipses last through the long run of about 1,300 years. The moon's ecliptic limit being

about 24° while the sun's is 36°, accounts for the shorter time that the lunar series can be seen from the earth. And the earth's shadow where the moon passes it being smaller than the earth itself, accounts for the shorter ecliptic.

As an example to illustrate the application of the Saros, let us take a total eclipse of the sun which occurred in 1806, June 16th. It was a very large total eclipse and visible in Ohio and New York about eleven o'clock A. M. But instead of using our common twelve-hour division of the day, it is better in calculations of this kind to count the twenty-four hours through, and thus avoid the use of A. M. and P. M., and for the convenience of western readers I will use Kansas City time, which is *about* one hour earlier than eastern Ohio, etc. Then the date to start with would be 1806 6mo. 15d. 22h. In determining the leap-years I have found it convenient to write them in a vertical column, beginning with 4, 8, 12, 16, 20, etc., all through the century. This shows every year which has twenty-nine days in February, and makes it quite easy to ascertain whether we must use 10, 11 or 12 days in any particular Saros. The same column will do for any century.

	MO.	DAY.	HR.
1806 . .	6	15	22
18 . .	0	10	8
1724 . .	6	26	6
18 . .	0	11	8
1842 . .	7	7	14
18 . .	0	10	7
1860 . .	7	17	21
18 . .	7	11	8
1878 . .	7	29	5
18 . .	0	10	8
1896 . .	8	8	13
18 . .	0	12	7
1914 . .	8	20	20

We observe that the first period, 1806 to 1824, has five leap-years; that is, the 29th day of February occurs five times before the period ends, which is in June. So we must add only ten days with the eighteen years. It may be observed that if the Saros ends before the 29th day of February, that leap-year is not to be counted in that Saros; but if after that day it must be. It may be noted also that the seven hours and forty-three minutes is not always the *exact* part, or fraction, of a day to the actual occurrence of the eclipse. It is only the mean, or average, part of the day for all periods. There are slight irregularities in the moon's motions which can only be got at by a tedious process of calculation. So that the nearest hour is quite sufficient for our purpose. Hence we add eight hours twice (in two different periods), then seven hours once, and so on. So we obtain 1824 6th mo. 26th day, six o'clock in the evening, Kansas City time, for the date of the return of the 1806 eclipse. The sun not being then set the eclipse must have been visible over northwestern America and the Pacific Ocean.

You may observe too, that, the eclipse being nearly eight hours later in the day than the preceding one, it must be about one-third of the way round the earth farther west than its predecessor. The next Saros having but four leap-years, we add eleven days to six months and twenty-six days and have six months and thirty-seven days, from which subtract the thirty days of June, and we obtain for the next eclipse, 1842, July 7th, two hours after midnight. Of course it could not be seen here, the sun being away below the eastern horizon. But in the early morning of July 8th, the people of eastern Europe had a fine view of one of the grandest eclipses of modern times. It was then that the red flames

and sublime corona began to attract great attention from the most gifted astronomers. Total eclipses occurred in other parts of the world, as that of 1851 in Norway and Sweden, whither great numbers of observers proceeded for the observation of these important phenomena. And in 1868 a goodly number of interested astronomers visited Arabia, etc., where they saw another total eclipse of the sun, and found evidence that the red flames, or tongues of light, were of a gaseous character, and perhaps were vast flames of burning hydrogen on the solar surface. But to our Saros: The above calculation gives, when reduced from astronomical to civil time, July 18, 1860, nine o'clock in the morning, for another eclipse in the 1806 series. And on the third return, fifty-four years and one month, it ought to be visible in Ohio, etc., again. But it would only be a partial eclipse; for the central shadow of the moon—the belt of totality, had gone northward about 300 miles. I well remember seeing this eclipse about eight o'clock that morning. The Saros time was one or two hours too late—a small matter though for more than fifty years' time.

Doubtless many persons remember the solar eclipse of 1878, July 29th, about three or four o'clock in the afternoon. The total belt ran from Behring's Strait near the Pacific coast, but a fine partial eclipse (about half the sun's face) was visible even here. It was raining for some time after the eclipse began; but the clouds broke away in time for a fine observation of the greatest phase. Rain was falling again, however, before the eclipse ended.

I have often noticed and heard of such *clear spells*, as if by special Providence to allow observations of eclipses and other interesting phenomena.

The next return, 1896, August 8th, about midnight, being on the opposite side of the earth, we will see nothing of it here. Now we come to the close of a century, the last year of which is not a leap-year; and there are but three Februarys having twenty-nine days in that Saros, so twelve days must be added with the eighteen years and seven hours to obtain the day of next return; which, according to Rev. S. J. Johnson in his book, "Eclipses Past and Future," will be at noon August 21, 1914; corresponding well enough with our calculation, making allowance for difference of longitude. He says "it will be a most striking phenomenon"—visible in Norway and Sweden. "At London two-thirds of the sun's disc will be eclipsed." Adding another Saros of eighteen years, ten days and eight hours, we get 1932, eight months, thirty days, four hours. I do not find any record of this eclipse; but it certainly will occur very early in the afternoon of that day, and be visible to Kansas City as a small eclipse of the sun. Johnson does not mention the return in 1950, but that of 1968, September 22d, at ten A. M. (London time), he gives as obscuring one-third of the sun's diameter. The line of totality must then be near the north pole, but the partial eclipse will continue in the arctic regions, growing less and less at each returning Saros until the year 2347, May 11th, seven o'clock in the morning, when, according to my own calculation, the southern edge of the moon will overlap the north side of the sun, about 0.08 of the sun's diameter—nearly one digit by the old way of noting the magnitude of an eclipse. To determine this matter requires a process of compu-

tation more tedious and accurate than can be done by the Saros. And so I find that in eighteen years more, viz., 2365, May 21st, at two P. M., the shadow of the moon seems to miss the earth entirely. And now it must continue to traverse the void expanse of space for the long period of nearly thirteen thousand years before it again touches the south pole of the earth to begin another series of spiral visits northward on the mundane sphere.

Now, we may find when eclipses of this series occurred previous to 1806 by subtracting the Saros period. Then from 1806 six months, fifteen days and twenty-two hours take eighteen years, twelve days and eight hours, and we have 1788, June 3d, two hours past midnight, Kansas City time. By reference to a long catalogue of eclipses in Ferguson's Astronomy, I find that this eclipse—that is, one eclipse in this series—was visible at London 1788, June 4th, at nine A. M.; which is very near our Saros time—allowing for difference of longitude. Then from this date we subtract eighteen years, ten days and eight hours and get 1770, May 26th at 6 P. M., which would be visible in western Asia and the Pacific (each preceding eclipse being visible eastward instead of westward, as when we added the Saros). So we might trace backward period after period for several centuries, and obtain, nearly, the times when this eclipse has been visible in the remote past. But remember, it has been going northward at every succeeding period; and as we go backward, it was farther south in the preceding periods. It was central on the equator, I think, about 1700. The farthest back, or earliest record, that I find of this eclipse was 1572, January 25th, at seven A. M., London time. At this hour in the morning the sun had not risen at London; but the eclipse must have been visible as a total eclipse in southern Africa. I have not applied the Saros back to this date, but calculation by a different process agrees exactly with the record. By a careful and somewhat tedious computation I obtain the date of 1049, March 12th, when this eclipse first came on the earth at the south pole. In 1031, March 2d, the moon's shadow seemed to nearly graze the earth, and at the next return in 1049 was fairly on; so that, from the south pole, the moon would seem to cover about one-twentieth of the sun's diameter. Although this eclipse was largely total when it passed over Ohio in 1806, yet my computations indicate that it was annular when it first struck the earth in 1049. That it became total about the time of its return in April, 1103, and will continue so until 1969, when it will again become annular; that is, the moon will get farther from the earth and appear less than the sun.

Not having found in any work on astronomy an account of this change from annular to total eclipse, I had always thought that if the eclipse was annular when it began to appear on the earth, it would continue so during its whole periodical round of a thousand years or more. But I find in these calculations a slow and continuous change in the relative distances of the sun and moon from the earth, Saros after Saros causing a change from the ring to the total eclipse. Then, to summarize a few of my results in reference to the solar eclipses of 1806, 1878, etc., viz: It came on at the south pole of the earth as an annular eclipse March 12, 1049; became total April 15, 1103; reached the equator—middle of its spiral

course on the earth about 1700; visible as a total eclipse in our latitude, June 16, 1806; becomes annular again about 1968, September 22d, and finally passes off or leaves the earth, at the north pole, May 11, 2347.

Hence this eclipse will have continued its eighteen-year visits to the earth during 1298 years and two months; having made itself visible on some part of the globe seventy-three times—making seventy-two complete Saroses. When it first struck the earth in 1049, it appears that the sun was 16° 13′ east of the moon's descending node; and when it leaves the earth in 2347, that the sun will be 17° 12′ west of the same node; having gone backward through an arc of 33° 25′ of the moon's orbit, which in this case would seem to be the "ecliptic limit." Now as the sun will have retrograded (with reference to the Saros) 33° 25′ in 1298 years, to go around the remaining part of the moon's orbit, *i. e.*, 360° 00′ —33° 25′=326° 35′, will take 12,687 years, the time that must elapse before this eclipse can fall on the earth again. Now, these results being only those of my own investigation, I do not claim absolute accuracy for them, but feel satisfied that the most elaborate computer will not find them greatly in error.

In contemplating that about forty-one such eclipses as this, and twenty-nine eclipses of the moon, are each one all the time making their periodical rounds of eighteen years about the earth, there might seem, at first view, to be an irregular and uncertain clashing, as it were, of dates and shadows, with other phenomena of eclipses, which could hardly be reconciled. But it is a fact absolute, that the various and intricate motions of the earth and moon are so well known that their positions with each other and the sun can be obtained at any time; and thus the dates of all these seventy eclipses foretold to within a few seconds of the times of their occurrence, for many years in the future.

"Great and marvelous are thy works, Lord God Almighty. Just and true are thy ways, thou King of Saints."

HOW TO WEIGH THE SUN.

BY EDGAR L. LARKIN, NEW WINDSOR OBSERVATORY, ILL.

There are several methods, and we select the most elementary in the attempt to make the case clear by the use of words instead of mathematical symbols, if such a thing is possible. Useless sentences must be written where, if the subject were treated mathematically, a few Greek letters and algebraic formulas would express all in clearer terms. What we shall say is intended to assist youths just beginning to expand their minds in the study of astronomy; and we will be pleased to receive letters from all such students between the ages of twelve and seventeen years, who have read this article and are interested in the noblest of all sciences.

GRAVITY.—If a body at rest begins to fall, it will fall sixteen and one-twelfth feet, or 193 inches, the first second; but at the end of the second, it will be moving at the rate of thirty-two and one-sixth feet, or 386 inches, per second. Among

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all the millions who lived before Newton, not one knew this fact to be valuable. But it is one of the most important elements of human knowledge, since none can learn much of nature, nor understand what kind of a world they are living in, nor comprehend the solar system, without first knowing all the results derived from this great fact. Let us see what it enables man to know. First, the velocity, 386 inches per second, acquired at the close of the first second of fall, is a measure of the gravity of the earth. It shows that a mass of matter of the size, shape and density of the earth, attracts with a force which, acting one second on bodies near its surface, is able to impart to them that velocity. For ordinary purposes of life we express gravity in terms of weight, and use scales graduated to arbitrary standards to compare the force of attraction of the earth on different bulks of matter. We take a piece of iron and say, by agreement, that it is one pound. That is, the mass of the earth attracts it with a force the measure of which we call a pound. Now if we let the iron fall from a high building, we shall find that at the end of a second it will be in motion with a velocity of thirty-two and one-sixth feet per second, therefore it is plain that if the nations of the world agree to call this velocity generated in one second a measure of the earth's attraction, scientists can write letters from one country to another, and speak of gravity in terms of motion as well as they can in terms of weight. And physicists all over the world have made such agreement, and have adopted one second as the unit of time, and velocity of 386 inches as a measure of gravity exerted by the whole mass of the earth. But this method of measuring gravity is used only in astronomical and physical research into the mysteries of the universe, the plan of expressing attraction in terms of velocity being preferable.

When clocks were perfected, it was found that one keeping exact sidereal time in London would lose if taken to the equator. Or, carry a clock that keep precise time at the equator, either north or south, and it will gain; the further we recede from the equator, the faster the clock will run. These facts seemed inexplicable until a clock that kept accurate time on the surface of the earth was taken into a deep mine and also found to gain. It is evident that the reason why a clock gains as it is carried toward the poles, is because in so doing we draw a little nearer the centre of the earth. Then the idea came into men's minds that gravity is variable; and that its variation is connected in some way with distance from the earth's centre. And by pendulum experiments it is found that if we could reach the poles of the earth, we should be thirteen miles nearer its centre than if at the equator. Hitherto philosophers had thought gravity constant, but now they made a discovery of vast importance; they found that it is not the same everywhere on the earth. But then, if the pendulum varies its number of vibrations with latitude, will not the velocity of a falling body vary in the same ratio? Delicate tests were made in many latitudes and at the equator, when behold! the further we go away from the equator, the greater velocity will a falling mass acquire at the end of a second. But the whole increase in velocity from the equator to the poles, is only 1.97 inches; while the difference in distance from the centre of the earth is thirteen miles. The great question arose

just before Newton, what is the *law* of variation? And there was not found one among men able to solve the problem.

Before we proceed, it will be well to remark that physicists at that time did not know the amount of variation of velocity at different points on the earth's surface as we do now. They did not have mathematically exact clocks nor refined instruments of measurement; all they had as a basis to work on was an impression, simply, that gravity varied slightly, and that this variation depended in some way on distance from the centre of the globe. These things render more remarkable the achievement of Newton. Let us now, along with that great man, begin a search for hidden law, and propound such questions as these to our own minds, as he did: How great a velocity will a falling body attain in one second if let fall from heights of five, ten or fifty thousand miles above the surface of the earth? How shall we learn? we cannot reach these altitudes; is there no way to find out? There is,—but none save Newton can tell us. Let us see; the moon is above the surface of the earth, and if gravity reaches that far, it must be a falling body. Conceive the earth and moon to be called into existence instantly, then the moon must begin to fall toward the earth at once, since our world contains eighty times as much matter. And if the attraction of the earth is as strong there as it is on its surface, the moon, at the termination of the first second of its fall, must be moving with a velocity of 386 inches per second, directly toward the centre of the earth. Now we all know that the moon does not approach the earth, although terrestrial gravity is exerted upon it all the time, making it tend to fall; and fall it would, did there not exist some force able to hold it back. What is this force? Tie a cord to a stone, and revolve it rapidly around the hand; the string will be found to pull with a force which varies in some ratio to the velocity. Make the stone revolve twice as fast, and even with the hand it can be detected that the pulling sensation is more than twice as strong as before; while with instruments it is demonstrated that the centrifugal force varies as the square of the velocity. So with the moon; its velocity generates centrifugal force which draws against the attraction of the earth precisely as the stone against the hand. Behold! we are in the midst of an inductive process which leads to a law of Nature. Is it not clear, that, if we can find how much centrifugal force is evolved by the motion of the moon, we shall at once know how strong the earth attracts at that distance, since we already know these two forces are equal, because the moon does not come nearer the earth? But how shall we find the centrifugal force of the moon? It is developed by analysis that if a body in space revolves around another with velocity sufficient to prevent gravity from causing them to approach, the velocity of the revolving body must equal the square root of the product of gravity multiplied by the radius of its orbit. The mean equatorial radius of the earth is 3962.72 miles, and the mean distance of the moon is just sixty times as much, or 15,064,676,352 inches. And the force of gravity exerted by the earth at the distance of the moon, let us assume, is equal to a force which, acting one second, could make the moon move in centripetal fall, at its close, with velocity of 386 inches per second. Now multiply the above number by 386,

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extract the square root of the product, and we shall have 2,411,631 inches per second, through which the moon must move in orbital flight to make centripetal force equal gravity and keep it from falling.

But we should have strange times on the earth; we should be blessed with more than two moons every day, for with this velocity the moon would make a revolution in ten hours fifty-five minutes, giving us new moon in the evening, say at 6 o'clock P. M., and full moon before midnight. We could see it move, and would wonder at the unusual aspect of Nature. Hence we are sure that gravity is not any where near as strong at the moon's distance as on the earth's surface. Let us try again, and since the moon is sixty radii of the earth away, conceive gravity to be one-sixtieth as strong. Divide 386 by sixty, and the quotient is 6.4333 inches, which we will assume as the velocity gravity can impart in one second at the moon's distance. Using this as a multiplier in the same computation as before, and we obtain orbital velocity per second of 311,152 inches to balance gravity. By dividing the circumference of the lunar orbit by this number, we find the time of revolution, which is three days, twelve hours and thirty minutes, and are assured that gravity is far less than one-sixtieth of what it is on the earth, because the moon requires over twenty-seven days to make circuit. We have not yet found the law, and how shall we proceed? Is the problem capable of solution? Let us take a reverse method and begin with the actual velocity of the moon on its orbit, and see how much attraction the centrifugal force generated by that motion balances. Centrifugal force produced by a revolving body is equal to the square of its velocity, divided by the radius of its orbit. The moon goes around the earth in 2,360,591 seconds, with velocity of 40,098 inches per second. Square this velocity and divide the product by the number of inches in the mean distance of the centre of the moon from the centre of the earth, and the quotient will be 0.1072 of an inch. That is, the centrifugal force developed by the moon's orbital motion is equal to a force which, acting one second on a body at rest, could at the close of the second cause it to move with that velocity per second. But we know this force to be equal to the gravity of the earth at the distance of the moon, because the moon does not come any nearer. Now how much weaker is this gravity than it is on the surface of the earth? Divide 386 by 0.1072 and the quotient is 3,600; it is 3,600 times less, but behold 3,600 is the square of sixty, and sixty is the ratio of the distance of the moon from the centre of the earth to the distance of the surface of the earth from its centre. The mighty mind of Newton saw the great results of this law, as they would be developed from age to age; and his intellect beheld that in time to come, it would enable man to weigh suns so distant that light requires years to traverse the awful chasm to reach our world. Newton published the law and rendered his genius the subject of admiration so long as intellectual man shall inhabit the earth. It is this: "Every particle of matter attracts every other directly as to mass, but *inversely* as to distance squared."

WEIGHING THE SUN.—When we wish to weigh anything we must have scales; but what scales will weigh the solar mass? How shall we begin; and when we have told its weight, how shall we know it to be correct?

Our balance shall consist, not of instruments of steel, but of *motion*, whose amount is only 386 inches in one second, or that velocity developed at the close of a second on an insignificant world more than 92,000,000 miles away from the great sun it is proposed to handle! How absurd such an undertaking seems, but no matter; men became bold as soon as they learned that gravity varies as distance squared inversely, and attacked problems that would have appalled the human intellect before.

The distance of the centre of the sun from the centre of the earth is 23,440 times greater than the surface of the earth is from its center. We know gravity to be measured by the 386 inches, at a distance of 3,962.72 miles from the centre of our earth; how much will it be weakened at a distance 23,440 times as great? The law says it will be lessened as the square of the ratio of the distance, inversely; hence, 23,440 squared equals 549,433,600; that is, gravity will be diminished that many times at the sun's distance. Divide 386 by this number; the quotient will be .0000070254 of an inch velocity, at the end of a second, that the attraction of the earth is able to impart to a falling body that far from its centre. Proceeding as we did in the case of the moon, we multiply the number of inches from the centre of the earth to the centre of the sun by the force of gravity, or the decimal given, resulting in 4,134,635 inches per second, which is the square of the velocity with which a body at that distance must move in order to counteract that much attraction and not fall. Extracting the square root, we have 2,033 inches per second as the real orbital motion. Now, by finding the number of inches in the circumference of a circle having the above radius, and dividing by 2,033, we find the time of revolution, 576.3657 years. But to make circuit in one year it must move 576.3657 times as fast, or 1,171,751 inches per second.

It is clear that if we can find how much centrifugal force this velocity generates, we shall at once know how strong gravity is at that distance, and how much matter is required to exert that attraction. As before, centrifugal force is found by dividing the square of the velocity by the radius of the orbit. Therefore 1,171,751 squared equals 1,373,000,406,000, which divided by 5,885,266,907,520, the inches in 23,440 times the earth's mean equatorial radius, or the mean distance of the sun, gives a quotient of .233 of an inch per second, velocity generated at the end of a second by a force equal to the centrifugal force found acting during that time.

But this is also equal to gravity; now, how many times stronger is it than what we found by dividing 386 by the square of the distance? We find how much by dividing .233 by .00000070254, and find it to be 331,654 times as great. Hence, the earth must become 331,654 times heavier than it is to make a body at the sun's distance revolve around it in a siderial year, and not fall. Since the

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earth revolves around the sun in a year, we have demonstrated the sun to be that many times greater in mass than the earth.

PROOF.—How are we to be satisfied that this result is correct? The distance to the sun is known; and the time of the revolution of the earth around it, which is 31,558,149 seconds; we know the number of inches in its orbit, and of course the number traversed in a second. Draw a tangent to the orbit of the earth, and let the centre of the earth be at the point of tangency; in one second it will be 1,171,751 inches away, but the centre will be .1165 of an inch nearer the sun than the tangent is, showing that the world falls that far every second from where it would have been had not solar gravity drawn it away from the tangent; because, if in whirling a stone the cord should break, the stone would fly away on a straight line tangent to the circle in which it moved. But .1165 of an inch is the half of .233, and 16 1-12 feet is half of 32 1-6 feet, the velocity attained by a falling body on earth; that is, the velocity acquired by a mass falling from a state of rest is, during the first unit of time, equal to twice the space fallen through. Hence it is seen that geometrical analysis of the orbit traversed by the earth gives the same value, precisely, for solar attraction that is found by the more elegant method of using the velocity, 386 inches, as an instrument of weighing. We have simply deduced ratio of mass; that is, call the weight of the earth one, and that of the sun is 331,654. Now, if we can find how many pounds the earth weighs, the weight of the sun, in pounds, can easily be computed. From most delicate pendulum and other experiments, it is found that the mean density of the whole earth is 5.66, that of water being one. A cubic foot of water weighs 62.-594 pounhs; hence, a cubic foot of the earth weighs 5.66 times as much, or 354.28 pounds. Find the cubic feet in the earth, multiply by this factor, and that by the ratio of weight of the sun to that of the earth, and the product will be the number of pounds of matter in the sun.

NEW WINDSOR, ILL., February 1882.

ASTRONOMICAL NOTES FOR MARCH, 1882.

BY W. W. ALEXANDER, KANSAS CITY, MO.

THE SUN.

Date.	Right Ascension.	Declination S.	Equation of Time.
1st.	22h. 50m.	7° 25′	12m. 27s. +
10th.	23 24	3 56	10 19
20th.	0 00	0 00	7 29
31st.	0 40	4 18 N.	4 08

On the 20th at 11h. A. M., it will enter Aries, pass the celestial equator and Spring will commence.

MERCURY.

Date.	Right Ascension.	Declination S.	M. T. of Meridian Transit.
1st.	21h. 50m.	10° 15′	11h. 08m. A.M.
5th.	21 47	11 32	10 49
10th.	21 51	12 21	10 34
15th.	22 04	12 17	10 27
20th.	22 22	11 27	10 26
25th.	22 44	10 00	10 28
31st.	23 09	7 25	10 34

Apparent diameter on the 1st, 10.2″; on the 31st, 6.2″.

VENUS.

Date.	Right Ascension.	Declination S.	M. T. of Meridian Transit.
1st.	23h. 00m.	7° 56′	00h. 22m. P. M.
10th.	23 41	3 29	00 28
20th.	0 27	1 35 N.	00 34
31st.	1 17	7 08	00 41

Apparent diameter on the 1st and 31st, 10″.

MARS.

Date.	Right Ascension.	Declination N.	M. T. of Meridian Transit.
1st.	6h. 04m.	26° 21′	7h. 25m. P. M.
10th.	6 16	26 07	7 02
20th.	6 32	25 46	6 38
31st.	6 52	25 15	6 15

Apparent diameter on the 1st, 10″; on the 31st, 8″.

JUPITER.

Date.	Right Ascension.	Declination N.	M. T. of Meridian Transit.
1st.	3h. 11m.	17° 03′	4h. 33m. P. M.
10th.	3 17	17 27	4 04
20th.	3 24	17 56	3 32
31st.	3 33	18 28	2 57

Apparent diameter on the 1st, 35.4″; on the 31st, 33″.

SATURN.

Date.	Right Ascension.	Declination N.	M. T. of Meridian Passage.
1st.	2h. 25m.	12° 07′	3h. 48m. P. M.
10th.	2 28	12 25	3 15
20th.	2 32	12 46	2 40
31st.	2 37	13 11	2 01

Apparent diameter on the 1st, 16.2″; on the 31st, 15.4″.

The elevation of the earth above the plane of the ring, 19° 50′.

URANUS.

Date.	Right Ascension.	Declination N.	M. T. of Meridian Transit.
1st.	11h. 12m.	5° 59′	ooh. 36m. A. M.
31st.	11 07	6 28	10 30 P. M.

NEPTUNE.

Date.	Right Ascension.	Declination N.	M. T. of Meridian Transit.
15th.	2h. 50m.	14° 32′	3h. 10m. P. M.

PHENOMENA.

On the 5th at 3h. 37 A. M., conjunction of Uranus and the Moon. Uranus north, 6° 06′.

On the 6th, at 10h. 00m. P. M., opposition of Uranus and the Sun.

On the 7th, at 6h. 00m. A. M., Mercury stationary in R. A.

On the 17th, at 11h. 00m. A. M., conjunction of Mercury and the Moon.

On the 19th, at 10h. 23m. A. M., conjunction of Venus and the Moon. Venus south, 5° 47′.

On the 20th, at 11h. 00m. A. M., the Sun enters Aries and Spring commences.

On the 21st, at 5h. 00m. A. M., Mercury at greatest elongation, west 27° 46′.

On the 22d, at 5h. 00m. A. M., conjunction of Saturn and the Moon.

On the 22d, at 11h. 00m. A. M., conjunction of Neptune and the Moon.

On the 23d, at 2h. 00m. A. M., conjunction of Jupiter and the Moon. Jupiter south, 1° 23′.

On the 26th, at 4h. 40m., conjunction of Mars and the Moon. Mars north, 5° 39′.

On the 31st, at 4h. 00m., Mars at greatest heliocentric latitude north.

ST. LOUIS ACADEMY OF SCIENCE, February 6, 1882.

Prof. Pritchett made a short communication on double stars. He stated that some stars were found to have a periodic motion such as had been observed in double stars which revolve around the common centre of gravity. Of these Sirius was one, and a German astronomer calculated the position of a companion star which would produce the observed deviations. This companion star was afterward discovered by Clark, when the Chicago telescope was turned upon it. It had also been observed that Procyon had a proper motion similar to that of Sirius, and attention was at once drawn to it in the confident expectation that a similar explanation of its variable proper motion would be obtained. Up to the present time, however, no satisfactory evidence has been given of the existence of such a companion, although the search has brought out some curious results. Some years ago, Prof. Otto Struve, Director of the Pulkova Observatory, announced the discovery of a close companion, and although no other astronomer was able to see it, Struve continued to measure the companion for two years. At the end of

this time, however, he concluded that the object he had observed was a spurious one, caused by a double reflection of the light from object-glass and eye-piece.

With the great twenty-six-inch equatoreal at Washington, a systematic search was commenced, in 1876, for companions of Procyon, a number of observers taking part. Of these, the majority never saw any companion; two or three were uncertain, while two or three others saw from two to eight companions at different times.

METEOROLOGY.

ON THE CAUSE OF THE ABSENCE OF TREES ON THE GREAT PLAINS.*

BY LESTER F. WARD A. M.

The many fine-spun and often puerile theories that have been advanced by men of greater or less scientific reputation to account for the treeless condition of a large part of our country, are responsible for the continued prominence of this old and familiar question. The latest utterance on the subject comes from Prof. Thomas Meehan in the form of a "Note on Treeless Prairies,"† in which, to his credit be it said, he has undoubtedly given the proper solution to the problem, so far as the proper "prairies" are concerned, namely, that they are due in the main to the annual fires that have from time immemorial swept over these areas. This conclusion, however, is far less fresh than the language in which it is announced would imply that he regarded it. Dr. C. A. White, then State Geologist of Iowa, in his annual report for 1870,‡ expresses his view as follows: "It now remains to say, without the least hesitation, that *the real cause of the present existence of the prairies in Iowa is the prevalence of the annual fires.* If these had been prevented fifty years ago, Iowa would now be a timbered instead of a prairie State;" and Dr. Alexander Winchell remarks§ that "The old and popular belief was that which attributed their treelessness to the annual burning of the grass by the Indians."

Born and raised in the prairie region, I can fully confirm the testimony of these two Western men, and add that this explanation was the only one that I am aware of having ever received any serious attention from the class of practical people whom I was accustomed to hear speak on the subject; all others being dismissed as the efforts of over-learned persons to give some other reason for things than that dictated by plain common sense. The formal ratiocination by

* Read before the Biological Society of Washington, December 9, 1881.
† Proc. Acad. Nat. Sci., Phila., Feb., 1881.
‡ Vol. I, p. 133.
§ Sketches of Creation, 1874, p. 266.

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which Prof. Meehan establishes his conclusion was as familiar to my childhood as the alphabet, and its extreme simplicity is virtually acknowledged by him a few lines lower on the same page, where, speaking of Indians, he admits that "Low as their power of reasoning may be, they could not but have perceived that while grassy herbage throve in spite of fires, perhaps improved under the fiery ordeal, trees could not follow on burned land. What could be more natural than that they would burn the prairies with the object of retaining food for their wild animals." Certainly what savages could reason out *a priori*, white men ought to be able to account for *a posteriori* with all the data at hand; and this they certainly have done from the first, and refused to be befogged by any of the other specious reasoning already referred to.

But the problem of the "grassy prairies" and the problem of the Great Plains are not identical. When we extend our inquiries to embrace the broad expanse that stretches westward from the Missouri and the western boundary of Arkansas to the base of the Rocky Mountains, we encounter a new class of phenomena which require to be accounted for on a different principle.

The investigation is, however, seriously complicated by the fact that between the very distinct conditions that characterize the typical prairies and the typical plains there is geographically no precise line of demarkation, the one passing into the other by rigidly insensible gradations.

In traveling westward from Kansas City or from Omaha, one passes through an almost completely treeless region for a distance of five or six hundred miles. A careful observer will, however, perceive that the eastern portion of this great plain differs in many respects from the more central or western portions, and that it may therefore be divided into two general areas, which, however, blend together and do not admit of being clearly marked off from each other. If it could serve any useful purpose to draw an arbitrary line to denote approximately the western boundary of the one and the eastern boundary of the other, this line might perhaps be made to coincide with the 100th meridian, which passes through western Kansas and central Nebraska. For a moderately limited north-and-south range, this line does not fall far from that represented by an altitude of 2,500 feet and an average annual rain-fall of twenty inches.

In point of fact, as regards this latter, which is of chief importance to our subject, the twenty-inch isohyetal, if followed southward from the Missouri River, which it crosses at a point near Yankton, or about on the 98th meridian, bears westward and touches the Kansas and Nebraska State line almost exactly at the 100th meridian. It continues slowly to bear westward and reaches the 101st meridian at the southern boundary of Kansas, crossing it, but returning to it at the Rio Grande, which it follows thereafter very closely to near its mouth.

This line as thus described would, therefore, still more nearly represent the imaginary boundary of these two treeless areas.

As we approach this line, proceeding westward, the grassy character of the plains gradually disappears, the typical prairie vegetation is changed and gives place to a new class of plants which are for the most part represented by three

dominant types: 1st. Those having thick succulent stems for storing up moisture, of which the cactuses are the best examples. 2d. Those having large and deep roots, such as *Ipomœa leptophylla*, the bulk of which is really subterranean; and 3d. Those having either glandular, hairy or woolly surfaces, belonging to numerous families, but chiefly to the *Compositæ*, the *Borraginaceæ*, and the *Leguminosæ*. Large interspaces of bare ground occur between the more and more sparse occupants of the soil; grass, when seen at all, appears in small, disconnected bunches; the face of the country assumes a dull, leaden hue, and the transition at length becomes complete.

A sojourn upon the plains for a short period reveals other marked peculiarities. The eastern sky is frequently seen lit up on summer evenings by flashes of lightning, and by day a bank of cloud may often be observed hanging low along the eastern horizon while all is dry and arid at the observer's station. Or, looking to the westward, heavy showers may be seen to gather upon the mountains, only to thrust a few spent cloud-columns over the parched regions below.

The prime cause of the changes in the vegetation above pointed out is therefore of course not far to seek. The scanty rain-fall would seem alone sufficient to account for it. After passing the western boundary of Kansas, the annual precipitation is but sixteen, and falls as one proceeds farther westward to twelve inches. The same is true throughout western Nebraska and Dakota and eastern Montana. At Denver it is 14.09; at Cheyenne, 13.77; at Fort Lyon, Col., 12.56; at Fort Stevenson, Dak., 11.84, and at Fort Rice, Dak., 11.39 inches.

Any country whose annual rain-fall is less than ten inches is a true desert, and we see how closely this great region approaches this condition at certain points. It is only rarely, and this either in natural depressions or in the vicinity of rivers, that green patches of buffalo grass, *Bontelona oligostachya* or *Buchloë dactyloides*, may be seen, possessing anything that can be called turf, and the face of the country has, to a large extent, the general aspect of a desert.

But if this deficient rain-fall accounts for the absence of grass and the other herbage characteristic of the East, is it sufficient also to explain the absence of trees? And if so, why is the country not timbered out to near the 100th meridian?

The first of these questions should, I think, be answered affirmatively. As to the second, it has already been answered at the beginning of this paper. It is, I believe, indeed true that there are no trees on the plains because they will not grow there, and it may be this opinion, (which *is* somewhat prevalent,) that Prof. Meehan has confounded with a similar explanation of the more eastern prairies; for at the beginning of his paper he remarks that "The most prevalent belief had been that trees would not grow on these prairies," a statement which is very wide of the truth for the prairies proper.

This view may be substantiated by a few facts:

1. It is not possible to account for the absence of trees on the plains on the theory of fires. Fires do indeed occur but not frequently or extensively. The vegetation is scarcely dense enough to support them. The testimony is conflict-

ing with regard to their extent and frequency even among those who have lived many years on the plains. My own inquiries, made of such persons, confirm the above statement.

2. All successful attempts to make trees grow on the plains have been made in irrigated districts, which is of course no test of their ability to grow in districts not irrigated. At least one unsuccessful attempt has been made, viz., that of the Kansas Pacific Railroad Company to plant them along their line.

3. It is true that three cottonwoods, *Populus monilifera*, *P. balsamifera*, and *P. balsamifera*, var. *angustifolia*, grow spontaneously along the valleys of streams in some places, one of which, *P. monilifera*, is often found far out on the plains. These, however, rather substantiate than disprove the theory here advanced, since, if the timber were destroyed by fires, the cottonwoods would share the common lot of all. In fact they furnish still stronger proof against the fire theory, for where they are found is just where the most grass grows, and hence where the fires would be most frequent and destructive. It is therefore safe to say that the general absence of arborescent vegetation is not due, as on the more eastern prairies, to annual fires.

To say that the distance from actual forests is too great for trees to migrate over the plains, would be not only to misapprehend the question, since they would have been there from the first, but would be to betray ignorance of the facility with which vegetation is known to traverse vast areas and find its way across continents, and even hemispheres of the globe. No point on the plains is too remote for the cottonwood to fail to reach it, provided the conditions for its growth exist, and if it be said that the peculiar anemophilous seed of this genus adapt it above other trees for finding a proper habitat, it may be replied that few other trees live in such small areas, so widely separated from one another as to require similar devices for scattering their seed. If the entire plain was capable of supporting a general forest growth, such as once existed in the Eastern States, the individuals of any species would be in such close proximity to each other that propagation by the ordinary methods would be as easy there as here.

The whole subject may therefore be briefly summed up as follows:

Since the elevation of the Rocky Mountain range at the close of the Tertiary age, the atmosphere, in the general easterly movement which it possesses at all latitudes within the United States, has at all times lost the greater part of its moisture by condensation upon the cold summits of these and the more western ranges, so that by the time it reaches the great plains it is too dry for precipitation except under unusual conditions. As it moves still farther eastward across a level country, having river valleys and lake basins, it comes in contact with currents from the north, the south and the east, brought there by the constant disturbances of barometric pressure with which all are acquainted, and in this manner it gradually becomes at length again sufficiently laden with moisture to yield portions of it to the soil when condensed by currents of unlike temperature. This characteristic becomes more and more marked with the eastern movement until the Mississippi Valley is reached, in which and at all points eastward the rain-fall, varying

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from thirty-two to sixty inches, is sufficient to be depended upon for agricultural purposes.

Where the annual precipitation is below twenty, or perhaps twenty-four inches, there can be no growth of forests, and this is the true cause of the absence of trees on the great plains. But this does not prevent the existence in arid regions of certain specialized types of arborescent vegetation. The sage brush that covers the dreary wastes of the Rocky Mountain Region, the Laramie Plains, the Bitter Creek Valley, and such vast areas of the West, while in its botanical characters it is little more than an over-grown weed, is to all intents and purposes a tree, and often attains a great age. The region it occupies is even more arid than the great plains, yet no fires occur and no forests grow. In the nearly rainless areas of Arizona, southern Utah and New Mexico, and stretching eastward into Texas, there occur a number of arborescent forms, the creosote bush (*Larrea Mexicana*), the mesquit (*Prosopis juliflora*), various acacias and mimosas, and one yucca (*Y. brevifolia*), together with the tree cactus (*Cereus giganteus*). These grow scattered at great distances from each other and rarely form thickets or groves. Why no such characteristic species are found occupying the great plains is not known, and it is probably a mere accident that none happens to exist, adapted both to their temperatures and their arid condition. Did any such exist, there seems no reason why it might not thrive as well as the sage brush farther west or the mesquit of the south.

The absence of forests or extensive tracts of timber land on those areas of our western country where the rain-fall annually exceeds twenty-four inches, must, as already remarked, be attributed to human agency in repeatedly burning over these areas, whereby all forms of vegetation requiring more than one season to mature their fruit are prevented from perpetuating their kind. The American aborigines have inhabited this continent through a prolonged period of the past, how long we need not here stop to inquire. Ages prior to European discovery they roamed over the great plains, hunting the buffalo, and through the forest-clad wildernesses to the eastward, hunting the deer, the elk, and the other large animals that belonged to the fauna of the country. Doubtless they found it advantageous to locate themselves at points near the boundary line which separates these great are as so well marked off by nature, where they could pursue the antelope by going westward or the deer by going eastward.

No human race has yet been found so low as to be ignorant of the art of making fire, and all along this border of the forest region we may imagine the red man's camp-fire to have glowed in periods too remote for profitable speculation. It is wholly unnecessary to assume, as Prof. Meehan has done, that the grass of these border wood-lands was fired intentionally or "with the object of retaining food for their wild animals." It is just possible that their knowledge that wild animals would be attracted to the sweeter grasses of newly burned tracts, may have led to the intentional burning of certain districts, but there is no need to call in this partial explanation. No Indian would ever attempt to check the ravages of fires accidentally allowed to escape, or prevent them from plunging into the

forest. Every one knows that this is constantly occurring in the camps of civilized men, who are responsible for the fact that in the regions over which they have displaced the Indian for nearly a century no growth of timber has yet been allowed to spring up as is its natural tendency. How much less, then, would savages restrain the agency of fire in reducing the forests of the Missouri and Mississippi Valleys to the treeless condition of the plains!

The prevailing winds throughout the entire section under consideration are from the west, and it is easy to see how, in a few centuries at least, the prairies of Kansas, Nebraska, Iowa, Missouri and Illinois might have resulted from this continuous holocaust of their pristine forests.

The very simplicity of scientific truths is often a bar to their acceptance, but science, as Huxley has said, is only common sense methodized and extended. Certain investigators seem to suppose that unless their labors succeed in bringing out some unexpected result no progress has been made. No problem has been more completely in the hands of this class than that of the timberless regions of North America.

This form of sensational science should be discountenanced as tending to warp the candid judgment of students of nature, and to divert them from the one sole aim of science, the discovery of truth.

If, therefore, in considering the facts from which the causes of the absence of arborescent vegetation upon the great plains must be deduced, I have reached a somewhat plain and commonplace conclusion, my only apology must be that no other conclusion has seemed to me to be warranted by those facts.

REPORT FROM OBSERVATIONS TAKEN AT CENTRAL STATION, WASHBURN COLLEGE, TOPEKA, KANSAS.

BY PROF. J. T. LOVEWELL, DIRECTOR.

Highest barometer during month 29.57, on the 22d. Lowest barometer during month 28.45, on the 26th.

Highest temperature during month 72°, on the 12th. Lowest temperature during month 10°, on the 30th.

Highest velocity of wind during month 46, on the 26th. Total travel, 12,473 miles.

Thunder-storm on the 18th.

The usual summary by decades is given below.

TEMPERATURE OF THE AIR.	Jan. 20th to Jan. 31st.	Feb. 1st to 10th.	Feb. 10th to 20th.	Mean.
MIN. AND MAX. AVERAGES.				
Min.	18.0	21.0	25 6	21.5
Max	40.0	49.1	56.0	48.7
Min. and Max	29.0	35 0	40.8	34.9
Range	22.0	28.1	30.4	23.5
TRI-DAILY OBSERVATIONS.				
7 a. m.	26.0	29.9	33.4	29.8
2 p. m.	36.3	51.1	47.9	43.1
9 p. m.	29.9	39.2	36.8	35.3
Mean	30.7	39.6	38.7	39.7
RELATIVE HUMIDITY.				
7. a. m.	.87	.86	.86	.86
2 p. m.	.82	.66	.65	.71
9 p. m.	.82	.80	.64	.75
Mean	.84	.77	.72	.77
PRESSURE AS OBSERVED.				
7 a. m.	29.02	28.94	28.93	28.96
2 p. m.	29.00	28.90	28.87	28.92
9 p. m.	29.02	28.91	28.92	28.95
Mean	29.01	28.92	28.90	28.94
MILES PER HOUR OF WIND.				
7 a. m.	15.5	10.5	11.8	12.6
2 p. m.	21.3	19.5	22.7	21.1
9 p. m.	13.0	14.1	18.7	15.3
Total miles	4296	3254	4923	12473
CLOUDING BY TENTHS.				
7 a. m.	6.5	1.8	6.8	5.0
2 p. m.	6.0	1.7	5.8	4.5
9 p. m.	3.0	1.0	5.3	3.1
RAIN.				
Inches	.10	——	.12	.13

JAPANESE METEOROLOGY.

BY ARAI YOSHINARI.

IDEAS ABOUT THE HEAVENS AND THE EARTH.—It is a very easy thing to look up into the heaven, but it is unlimitedly high. It is also a very easy thing to touch the earth, but it is unlimitedly thick. We can not go into the heaven nor can we go down into the earth. For reasons like these, there had been no astronomical instruments (observations?) for many years after the creation. They were afterward invented in the country called Jutania, in Europe. In China, the reason of the eclipse was not explained until after many centuries, but in the eighteenth year of Shigen in Gen (the name of ancient China), that is, 1281, A. D., it was understood clearly. Some astronomers have given their opinions about the motion of the earth, and some have given their opinions about the motions in the heavens. And the opinions about the rain or the wind, etc., all rest on the explanation of the male and female, or active and passive principles of nature. The rain is a changed form of the male principle of nature and the

vapour under the earth is a changed form of the female principle. When the male principal sinks down into the earth it would pursue the female. The earth is the mother of all things and produces many things, but the heaven is but the air or wind where the sun, the moon, and the stars hang shining. The air is divided into two kinds. One is called the heaven-air and the other is called the earth-air. The motion of the heaven is contrary to the running of water. The heaven turns round from the east to the west, but the water runs from west to east. The running of water is different with regard to the elevation of local districts. In some districts, where the northern part is low, the water under the earth runs in a northern direction, but when it is obstructed by the earth-air which comes from the north it is greatly agitated and commences to evaporate out of the surface of the earth. This vapour goes up into the air and is changed to the rain by the wind. The water has periods of increase and decrease according to the male and female seations. It is increased during the summer months because it is then the male season, and it is diminished during the winter months because it is then the female season.

When the earth-air goes from east to west it is changed to rain, although it is not always so with regard to the temperature of the seasons. Therefore, previous to rain, white vapor is seen, in the morning, rising up in the east. This is a clear proof of the earth's growing hot. It is for the same reason that the mountains become somewhat darker than usual, previous to rain, because vapour is sent up from the earth. In the district which slopes gradually toward the east, the earth-air passes through the earth from east to west, and a sound or smell is produced in the earth, as if coming from east to west.

On the 17th day of the fifteenth month of the ninth year of Bunkwa (1812 A. D.) it was very dark weather and hailed greatly but without thunder. This is an unusual occurrence. The thunder is produced by the intercourse of the male and female principles of nature. In the neighborhood of Asamayama in Shinshiu and other volcanoes, on the day of thunder, sounds are heard underground. This is due to the irritation of the earth-air, by which flames are sometimes sent out. It is said that a kind of beast accompanies the thunder and it runs about in the air. It is nothing strange, because it is said that in the island called Ampon which belongs to the country called Darunada, distant 3,900 *ri* from Japan, there are birds called Kasubara which are covered with fur-skin, instead of feathers; these eat fire; others feed on wind. As this world is unlimitedly great and extensive there may have lived strange beasts or birds, like the thunder-beast which we talk about.

The sound of thunder is just like that of a gun. The sound is heard after the lightning. When the quantity of water-clouds are very small in the heaven sound of the thunder is also very small and is heard as if it were very far off, but when the water-clouds are heaped up very much the sound and the lightning occur together. People should be afraid of the lightning but not of the sound because it comes after the lightning. The thunder is the sound of the fire which is produced at the time when it passes through the water-clouds in the heaven.

When this sound passes through the clounds with great power it is said to be a quick, great, and dangerous kind of thunder; but when it goes through very slowly it is of a weak and small kind. The ancients thought that thunder was the fighting between the water and the fire in the heaven, with regard to the rule of the male and female principles of nature, but this is very doubtful. If it were the fighting of the water and the fire, there is no reason for there being a space of time between the first thunder and the next. As it is wrought by the currency of the wind and thickness of the clouds through which the thunder passes, there may be the different sounds and spaces of time. The earthquake is but little different from the thunder. In the time of the earthquake, some sound is to be heard underground previous to it, because it is caused by the water in the inside of the earth, which was compressed for a long time by the earth-air, beginning to run forth.

The wind is said, by the ancients, to be the air which is produced from the sea or mountain. This world has always wind, but there is no strong wind unless it comes from the sea or mountains. The wind is of two kinds. One, or the upper wind, runs southward and the other or lower wind runs northward. The former comes from some mountains or the sea, and the latter is caused by the earth-air. The snow is the vapour which rises up from the earth. When the vapour which has risen up from the earth becomes frozen by the cold it falls on the surface of the earth again in the form of snow. Fog is also vapour from the earth. Haze is the vapour which has been mixed with smoke produced by some volcano. The frost is the frozen vapour sent up from the earth. Hail is sent from some mountains at certain seasons and falls on some parts of the earth. It does not fall on a great area.—*Japan Gazette.*

ENGINEERING.

THE IMPROVEMENT OF THE MISSISSIPPI RIVER.

A discussion is now going on before the House Committee on Levees and Improvements of the Mississippi River, the subject being the best method of preventing annual overflows and preserving a sufficient depth of water in the channel for large vessels.

The Levee Commission propose to continue the system recommended by the Board of Engineers of 1875, which requires levees to be raised at Cairo to the height of three feet, at Memphis and Helena seven feet, at Island No. 71 ten feet, at Lake Providence eleven feet, at Vicksburg and Natchez six feet, at the mouth of Red River seven feet, at Baton Rouge, Plaquemines and Donaldsonville five feet, at New Orleans four and a half feet. This work is proposed to be

done at a cost of about $100,000,000. The River Commission propose to close the outlets, and if they do they will re-establish the levee system recommended in 1875. They claim that the velocity of the stream must be maintained or shoals will be formed from the deposition of sediment at all points where the diminution is felt, and that the adoption of the "outlet system" will inevitably result in the formation of shoals below every outlet, while the construction of levees will confine the stream and thus keep up the velocity necessary to retain the earth and sand in suspension until the Gulf is reached. It is further claimed by the advocates of the levee plan that the best engineers of the country have repeatedly rejected the outlet plan.

The friends of the outlet system propose to open a channel *via* Lake Borgne into the Gulf, through which the surplus water of freshets will find its way instead of overflowing and devastating the adjacent country. Captain Cowdon, of New Orleans, in speaking before the Committee explained this plan as follows: "We leave the river ten miles below New Orleans with a fall of about fourteen feet in going to the lake, a distance of five miles. This lake is about forty five miles long, and has an area of some 300 square miles, and has a central depth of ten or twelve feet, and is a part of the Gulf of Mexico. To make this outlet we propose first to build two levees about a mile apart, one above and one below the outlet, running back from the bank of the river to the bank of the lake, to prevent the overflow of the plantations, above and below, in the rear. Then we have to clear off the timber and do some excavating. This can be done in about sixty days, and if the appropriation can be made in time, we can make the outlet this spring, so as to test it thoroughly and satisfy the whole country and Congress of the truth of what I say."

For this experiment only $250,000 is asked, and in support of the theory he further pointed out the usefulness of the outlets of the Atchafalaya, Morganza and Bonnet Carre in the floods of 1845 and 1877, when the water was higher at all points above than below them. He also claimed that since the narrowing of the river bed, by the construction of the jetties, the water had risen to a greater height at New Orleans and other points on the lower Mississippi than before.

There is also a practical illustration of the value of the outlet system and a practical reply to one of the principal objections of the Levee Commission in the fact stated that, while the outlets of the Mississippi have kept the river in its banks, the river has deepened its own bed from three to four feet from Greenville to the mouth of the Red River, a distance of 300 miles.

Captain T. P. Leathers, an old steamboat man, also made a statement to the committee, favoring the outlet system. Among other things he stated that the levee system was commenced above Red River, at Concordia, Tensas and Madison Parishes, by leveeing the low places and constructing small levees on the high banks. The levees were continued during a period of twenty-one years until 1857, and had pretty well controlled the water in that beat. In 1857, in low water, the water went eighteen inches lower by the bank than in 1836, but the lowest water we had was eight and one-half to nine feet. It showed a deepening of the water

by concentration in that section about four and a half to five feet. He thinks that the only way, and the quickest way, to relieve the country is to concentrate, to keep the water within its banks; and the outlet is the only plan that is possible to obtain the result, the mouth of the river being stopped up; as it is certain that not more than two-thirds of the water goes out now that went out of it eight years ago. It would be impossible to levee the river so as to protect the banks without giving the river an outlet.

The question at issue between the advocates of the two plans is whether the constriction of the channel of the river by the levees and the consequent slacking and backing up of the current will have a more deleterious effect than the checking of the rapidity of the flow below the outlets. We are not certain that the result in either case is correctly stated. If in both, the deposition of sediment would be similar in each case. If, however, as the engineers claim, the velocity of the current is increased by confining the water within its banks, the danger of its cutting the banks and levees during freshets will be largely increased, while on the other hand if the current below the outlet is liable to become in any degree less swift, it need only be so during high water, when great velocity is objectionable rather than otherwise; for if we understand the Cowdon idea it is simply to make use of this outlet in times of freshets and floods, as a safety-valve, so to speak.

The Atchafalaya River, or Bayou, has been found of immense advantage in relieving both the Red River and Mississippi in times of floods, and at this very time Senator Kellogg is asking a large appropriation for deepening it. The Commission, in speaking of the non-conformity of the Atchafalaya to their theory, say, "That the Atchafalaya remained so long unaltered, and is now evidently enlarging, is owing to important changes in the bed of the Mississippi near it, by which a large portion of the floods of the Red River have recently been discharged through it." The Commission made no recommendation regarding the Atchafalaya outlet except such work as is necessary to prevent its enlargement. Captain Suter, one of the Commission, has recently expressed himself favorable to a plan which will cut off the floods from tributary streams.

So far as we can see, this is precisely what the Cowdon plan proposes, viz: to create an outlet which will let off surplus water and of course control it to prevent detriment either to the country adjacent to and at the mouth of the outlet, or in the channel of the river below it. If a lock can be established and worked at Plaquimine, why cannot adequate engineering devices be conscructed to control the outflow at the Lake Borgne outlet? If works can be put in to prevent the enlargement of the Atchafalaya, why not along the course of the Lake Borgne outlet.

As to the "sub-delta" bugaboo, it is an old cry. The same engineers who oppose the outlet plan opposed the jetty plan, and on the same or similar grounds. A "sub-delta" would form at the extremity of the jetties and would continue to form there, no matter how far they were extended, but such has not proved to be the result. The whole question is confined to the possibility and feasibility of letting off the *surplus* water and retaining the *amount necessary* for navigation

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and carrying off the sediment. If this problem is insoluble, then the outlet plan is chimerical, otherwise it is sensible and practical.

Theoretically, the engineers may seem to have the best of it, but if actual experience shows the facts to be as stated by Captains Cowdon and Leathers, then the discussion ends and the choice lies with the least expensive and quickest plan. If it succeeds, millions will be saved to the government and it will take but a short time and a moderate sum to find it out. It cannot be a total failure, at the worst, as the experiment at Cubitt's Gap some twenty years ago has shown; and the probabilities are that with the improvements in modern engineering it will be a success. At all events, it will be many years before Lake Borgne can be filled up, and in the mean time Congress will be enabled to render some adequate relief to the Upper Mississippi and the Missouri, which cannot be expected should the levee system be continued at the vast expense required. Even with this object alone in view the bill introduced by Hon. R. T. VanHorn is a wise one and one calculated to be of infinite service to the people of the New West.

SCIENTIFIC MISCELLANY.

THE SCIENTISTS OF COLORADO.

BY MRS. FLORA ELLICE STEVENS.

The State of Colorado is admirably adapted for a general, broadcast scientific knowledge, boys and girls who do not know a Greek verb, and cannot construe a Latin sentence, talk familiarly and yet intelligently of "stamp mills," smelters, or concentrators; of galena, and know a granite formation wherever they see it, though doubtless this knowledge is in an inverse ratio to Mr. Louis Agassiz' neat conclusion upon scholars; these study nature in the open air, and in books they cannot find her. You may trip them up with learned terms, but they know that a difference exists between the rocks of Morrison and of the Garden of the Gods; and again, between these and those in the mountains of Georgetown, and they will stubbornly hold to it. So I repeat that it is a State of rare popular advantages for the growth of scientific thought.

Geology and mineralogy hold the leading places, but chemistry and philosophy are necessarily integral parts of their practical study. However, in this way it will be understood that most of the attention of scientists in this State is directed to those two divisions.

As well known a scientist as there is in the State, by reason of his researches in various fields and his sound and vivid observations, is Capt. E. L. Berthoud of Golden. An old army officer, he has been connected with the School of Mines

and Jarvis Hall, and with the C. C. R. R.; is perhaps the finest engineer in the State; while of the different branches of scientific research into which he

"Dips deep down, and brings the hidden waters up,"

his articles in the REVIEW are much better evidences than anything I could say beyond them.

Professor—now Senator—N. P. Hill has done a wonderful amount toward the development of his State, the success of his endeavors culminating in the works at Argo, two miles east of Denver. These are a combination of smelting, lixiviation and reduction. There is but one other such in the world, that at Swansea, Wales; and before these were built hundreds of thousands of tons of ores were yearly sent to Wales from this part of the country for treatment. The superintendent at Argo is a son of the superintendent at Swansea, and was induced by Senator Hill to accompany him to this country. The works are a wonderful reflection of the labor, time and study spent in their erection by the Senator. It may be added that he is on the senate committee upon the Smithsonian Institution; a pleasant recognition of his services to science.

Professor Richard Pearse, the metallurgist at Argo, is one of the leading men in that department in the State. He has made many valuable improvements upon the Swansea methods of refining and separating the copper matte so as to adjust it to Colorado ores. It may be proper here to state that the works were first located at Black Hawk by the old Boston and Colorado Smelting Company, but removed by Messrs. Hill and Pearse to Argo, because of its better facilities for obtaining fuel.

Prof. J. Alden Smith, the present State Geologist, is the one to whom Boulder County is very largely indebted for the discovery of telluride ores in supposed valueless rock in that district, which gave a lasting impetus to the mining interests of that county. His opinions are marked and valuable, and it is but a slight reward of his services that he received his present appointment from the Governor.

To the Episcopal Church and the late Bishop Randall, Colorado owes several of her scientists. Among those induced to come to Colorado through their means were Rev. E. L. Greene, quite well known as a botanist, now removed to California; Prof. and Rev. Arthur Lakes, an enthusiastic geologist, and Prof. E. J. Mallett, a chemist.

Prof. Lakes, who had classes at the School of Mines and Jarvis Hall, was an excellent teacher, as well as collector, and indefatigable in exploring the regions near and far that promised anything of interest. I have a pleasant memory of him when I was a school-girl. Our class in geology were having a day's excursion to Morrison, and the kindly Professor hearing of it, rode over from Golden to show us some of the interesting points thereabouts, though he did not reach home until midnight in consequence.

Mr. Mallett, who is a son of General Mallett, late consul at Florence, was for a while Professor of Chemistry at Wolfe and Jarvis Halls. Later he has

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built the Mallett reduction works at Cañon, which have been fairly successful. He has been a contributor to several scientific magazines as well.

Just at this time an old gentleman, Prof. Waitz, of Rosita, is doing some work that is attracting much attention. It is a process for separating low-grade ores and saving much of the ore that has hitherto been wasted. If the experiment succeeds, it will be of incalculable value to Custer, Fremont and some of the low-grade counties. And at any rate he deserves notice for the labor and experiments he has put upon his scheme.

These are but few of the scientists of the State of Colorado; to name them all, and their works, would be beyond the scope of a magazine article and beyond my powers as a delineator. As I said in the commencement of this article, the majority are metallurgists; I do not remember of any leading astronomers or meteorologists, other than those connected with the Signal Service at Denver and Pike's Peak.

The Hayden survey gave an additional impetus to the cause of science in the State; and the State Historical Association encourages it in its limited way, for it is not very large or old. A hall in the larger places might be secured, and courses of free lectures given with great profit; and more copies of the REVIEW, and journals of its class, taken throughout the State than are now. But Colorado is young and we may hope much for her.

The intelligent women of the State have sustained a loss in the death of Mrs. M. A. Maxwell, whose interesting exhibit of birds and animals at the Centennial is vivid in the minds of many who admired her for her devotion to the cause of science and the difficulties under which she labored. She made for herself an honest fame; and not her sex alone, but all who had heard of her skill, feel that her loss is a grave one.

A CHRYSALIS.

BY T. BERRY SMITH.

Only a chrysalis!
A seeming lifeless thing—a pulseless form!
No beauty there, you say; no current warm
Goes bounding on with swift vivific charm!
Is it only this?
A broken case wherein life used to thrill—
An empty cask no longer fit to fill—
Or does it hold a being living still?
Await a while and see.
And while we wait a change advancing fast,
We'll hie away and treat the wondrous past;
In memory's realms voluminously vast
We'll find out what it be.

Last year a worm went crawling o'er the earth—
A lowly creature sprung of humble birth ;
No flitting bird in all its warbling mirth
Espied it crawling round.
In autumn time when summer days were gone
And nature's garb was growing sear and wan,
Among the leaves that strewed the grassy lawn,
One day, by chance 'twas found.

'Twas snatched away from winter's icy whelm,
Put in a cup among some leaves of elm,
And there it spun a soft and silky film
Bewrought with wondrous skill ;
The silken warp was threaded round its form—
The filling weft was woven close and warm ;
And, lost to sight, secured from every storm,
'Tis resting calmly still.

And since the time it passed from human sight,
Has intervened full many a cheerless night,
And winter's train with bleak, relentless might,
All nature 'round has swayed ;
And weary months have passed with weary tread,
And living frames have hungered after bread ;
While dirges sad the wintry winds have said
Or wildest chants have played.

The weary while with all its storms and tears
Has brought this worm no racking pain, no fears;
Do sleep the dead thro' all their slumbering years
Unmindful of the time?
But now the spring, with sunlight mild and warm,
Will wake to life this seeming pulseless form :
Just so will rouse the Resurrection morn
The dead of every clime.

Two months I watched to see the bursting strange;
I thought to view the great and wondrous change—
The coming forth the vernal earth to range
Of that inswaddled worm;
But all the spring with its vivific hours
And twittering birds, its bursting buds, its flowers,
Had passed away, nor 'vailed its mighty powers
To rouse the slumbering germ.

The summer came—the lovely month of June—
When midnight choirs sing carols to the moon—
When stillest hours are at the sultry noon,
And shade is in demand;
Still nothing came aforth the sombre shell
Wherein I'd thought some being slumbered well;
But still I hoped the hope I could not quell—
To see the bursting grand.

I hoped to see it ope' its winding sheet
Wherein its rest had been so long and sweet,
And coming forth from that drear, lone retreat
To light of open day,
To quit the frame it once had suffered in
And take a form my pleased gaze to win,
Then spread its wings of gorgeous hues and thin
And lightly soar away.

BUT ALL IN VAIN. One day I went abroad,
Knew other scenes and other pathways trod,
Looked on the sun and saw the dripping cloud
Regladden all the earth;
Then when again to my accustomed place
I came and met with many a smiling face,
I also found my long beguarded case
Had given beauteous birth.

The silken tomb was rent and empty found,
No winding sheet now wrapt the pupa round;
The coffined form had felt its spirits bound
And burst its prison shroud;
I found at hand a large and splendid moth,*
Akin to that which weaves our finest cloth,
Whose wings were broad, nor made for moping sloth
But wanderings far and proud.

'Twas able now to wing the realms of air
Where skies were bright and landscapes broad and fair,
To gather sweets from blossoms fresh and rare,
And hither fly and yon;
Its home could be the airy fields of space,
Nor was it bound to any scene or place,
But, borne by wings as delicate as lace,
Could flit it on and on.

* **Polyphemus**, or American Silk-Worm Moth.

* * * * * * * * * * * *

So men have tried to tell the awful hour
When Christ the Lord would come with waking power
And rouse the dead from every dell and bower
To everlasting life;
They've thought to see the slumb'ring tribes of death,
Who, long or brief, have lain the earth beneath,
Arise and take their new undying breath
With flame immortal rife.

But after all, when no one thinks it near,
The judgment trump will sound its clarion clear,
And sleeping ones will all the summons hear
And leave their dreary clod;
Ignoble bonds will burst to loosen out
A glorious form with pinions new and stout,
Which swift will fly with glad triumphant shout
Thro' fields of space to God.

NEW INSECTS INJURIOUS TO AGRICULTURE.

Almost every year the appearance of some insect or insects injurious to agriculture, but previously unknown in an injurious capacity, has to be recorded. The present year (1881) has afforded several striking examples, as *Crambus vulgivagellus*, which has seriously injured pastures, *Phytonomus punctatus*, which has proved destructive to clover in the State of New York.

A new Pyralid has also very generally ravaged the corn plants in the Southern States. These new destructive species may either be (1), recently introduced species from some foreign country; (2), native species hitherto unobserved, or unrecorded, and new in the sense of not being described; (3), native species well known to entomologists, but not previously recorded as injurious.

The author argues that in the two last categories, more particularly, we frequently have to deal with newly acquired habits, and in the second category with newly acquired characters that in many cases systematists would consider of specific value. In short, he believes, that certain individuals of a species that has hitherto fed in obscurity on some wild plant may take to feeding on a cultivated plant, and with the change of habit undergo in the course of a few years sufficient change in character to be counted a new species. Increasing and spreading at the rapid rate which the prolificacy of most insects permits, the species finally becomes a pest and necessarily attracts the attention of the farmer. The presumption is that it could not at any previous time have done similar injury without attracting similar attention; in fact, that the habit is newly acquired. The author reasons that just as variation in plant-life is often sudden, as in the

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"sport," and that new characters may be perpecuated are thus created, so in insects there are comparatively sudden changes, which, under favoring conditions, are perpetuated. In this way characters which most systematists would consider are specific, originate within periods that are very brief compared to those which evolutionists believe to be necessary for the differentiation of specific forms among the higher animals.—*American Naturalist.*

BOOK NOTICES.

SUICIDE. By James J. O'Dea, M. D.; 12mo. pp. 322. G. P. Putnam's Sons, New York, 1882. For sale by M. H. Dickinson, $1.75.

In this work the subject of suicide is treated partly from a social and partly from a medical standpoint and is divided, generally, into studies of its philosophy, its causes and its prevention. Doctor O'Dea, from his professional position, both in Canada and the United States, is eminently fitted to discuss such a subject intelligently, having been one of the Board of Medical Examiners of Ontario and member of the Medico-Legal and Neurological Societies of New York, etc.

The causes of suicide are divided, generally, into the external or social and the internal or personal; the first again into general and special causes. The general causes exist everywhere and under all circumstances, having their source in extravagant religious and moral beliefs. These are illustrated by six chapters on Religion, Morals and Laws of Antiquity regarding suicide; such as the Doctrine of Continuity, the teachings of Brahmanism, Buddhism, of the Stoics, Epicureans and other schools of Pagan Philosophy; Suicide in Pagan Greece and Rome and among the Jewish people; six chapters on Religion, Morals and Laws of Modern Society, including suicide in the early Christian church, in the middle ages, in modern times; suicide and Roman common and modern law.

Then follows the special and personal order of causes, the first embraced in eight chapters on Age and Sex; Hereditary Influence—Insanity, Imitation; Education—Literature; Domestic Troubles, Love Troubles; Intoxicants, Financial Losses and Embarassments; Race, Nationality; Atmospheric and Climatic Influences.

Among personal causes, he classes bodily causes, mental causes, temperament, and considers the relations of insanity to suicide.

Under the head of Prevention are chapters on prevention by law, by religious and moral training, and by medical advice and treatment. We have thus given the skeleton of the work, and can assure the reader that this skeleton is well built upon and handsomely clothed. While the subject may seem better adapted to the professional than the general reader, its treatment will be found adapted to all intelligent persons who have a taste for historical and philosophical studies.

THE CYCLOPÆDIA OF PRACTICAL QUOTATIONS. By J. K. Hoyt and Anna L. Ward; octavo: pp. 899. I. K. Funk & Co., New York. Cloth, $5.

No recent publication that has come under our observation has given us so much genuine gratification as this. First, on account of the wide range of subjects touched upon, and the extensive list of authors of every age and nationality quoted. Second, on account of the admirable arrangement of the work, and lastly, on account of the remarkable skill displayed in the selection of the quotations themselves. It is one thing to gather together a quantity of ill-assorted and pointless or trite and stale sentences; quite another to select elegant, forcible and adaptable expressions—sparkling gems of thought in brilliant word-settings. In this respect the success of Mr. Hoyt and Miss Ward has been remarkable, which is necessarily due to the fitting combination of talent employed; the practical appreciation of the wants of the literary public by the experienced journalist, and the rare artistic skill of the cultured woman in making, almost by intuition, the proper selections; the business-like laying out of the work by the one, and the untiring, careful, earnest toil of the other.

It far exceeds any work of the kind that has ever been published, in size, scope and availability; no less than 625 double-column pages being devoted to English, Latin, French, German and Spanish quotations; over one thousand authors quoted and their names and nativities given; more than eleven hundred English and Latin subjects referred to, and more than two hundred and forty pages of three columns each filled by an exhaustive concordance, by which every quotation can be instantly found if the reader knows a single leading word of it. Seventeen thousand quotations are included in the work, besides definitions of ecclesiastical and law terms and phrases, etc.

We unhesitatingly recommend it to writers, teachers, students and all others who desire or require a work of reference of the kind, as unequaled and almost unsurpassable.

OPIUM SMOKING IN AMERICA AND CHINA. By H. H. Kane, M. D.; 16mo. pp. 156. G. P. Putnam's Sons, New York. For sale by M. H. Dickinson, price $1.00.

The author, who is also the author of "Drugs that Enslave," asserts that opium smoking is a vice that imperatively demands a careful study at the hands of the American people, from the fact that the practice, comparatively unknown amongst us six years ago, is now indulged in by some six thousand of our countrymen, male and female, whose ranks are being daily recruited; that large and small towns in the west and large cities in the east abound in places where this drug is sold and smoked, and that in some of our States it has become necessary to enact laws for its prevention and suppression.

Dr. Kane's account of the origin and spread of this vice in America is both interesting and startling; commencing in San Francisco, in 1868, and within fourteen years reaching to the above figures and extent, it is enough to alarm

the intelligent and thinking people of the country and arouse them to action. Aside from such statistics there is much information on the early history of opium growth in India; descriptions of opium-smoking places among the English, Americans and Chinese; the effects of the habit on different systems and organs; relative case of cure, mode of treatment; effects of the vice on the individual and on the Nation, etc.

BOOKS FOR ALL TIME.

READING DIARY OF MODERN FICTION. Compiled by F. Leypoldt and Lynds S. Jones: New York, 1882. F. Leypoldt.

These little books are intended as guides to aid in the purchase of books and to kindle a love of good literature. The first is the beginning of a series of catalogues which, when complete, will form an index to the whole field of literature. Those to follow are "The Literature of Knowledge" and "Books for the Young."

The "Reading Diary of Modern Fiction" is intended to present a survey of all that is considered worth reading in the domain of modern fiction. It is interleaved for the convenience of the reader in keeping up with the rapid advance in this department of literature, and will be found very useful in this respect.

Both are well conceived and can be made of great service to readers and book-buyers.

THE FIRST BOOK OF KNOWLEDGE. By Frederick Guthrie, F. R. S.; 12mo. pp. 130. G. P. Putnam's Sons, New York. For sale by M. H. Dickinson, price $1.00.

Notwithstanding some peculiarities of expression and manner, such as calling clay a "stuff" and classing air, fire and water under the general head of "elements," (afterward explained however), this book will be found a very useful one to teachers and scholars. A great deal of ground is gone over and much valuable information condensed in a clear and suggestive style into a small space. Questions to be asked the scholars are placed at the end of each chapter, which is a good feature, either at home or in the school-room. Some of the prominent subjects treated are things and stuffs used for house-building, heating and lighting, finishing and furnishing, clothing, food, writing and printing, etc.

OTHER PUBLICATIONS RECEIVED.

Sensation and Pain, by Chas. Fayette Taylor, M. D.; G. P. Putnam's Sons, 75c. The *Chicago Mining Journal*, edited by Wm. Hosea Ballou, monthly, $1.00. The Religion of all Sensible Men, with four other Sermons, by Rev. David N. Utter, of the Unitarian Church, Kansas City, Mo. The *Omaha Bee*,

annual review for 1881, (illustrated,) a handsome and valuable number. The Gold-Bearing Drift of Indiana, Geo. Sutton, M. D., Aurora, Ind.; pp. 9. The *Home Circle*, a Baptist monthly magazine, published at Philadelphia, Pa.; $1.50 per annum. The *Western Household*, published at Jefferson City, Mo., monthly, by John Meagher; 50c per annum. Atti Della Societa Toseana Di Scienze Naturali, Vol. III, November, 1881. *Manufacturer and Inventor*, Vol. I, No. 3, monthly, New York; $1.00 per annum. Causes of Deafness among School Children and its Influence on Education. Circular No. 5 from Bureau of Education.

EDITORIAL NOTES.

AT the February meeting of the Kansas City Academy of Science, Dr. Joshua Thorne presented a paper entitled "A New Theory of Volcanoes," which was received with interest. It was expected that it would be published in this number of the REVIEW, but as the illustrations could not be prepared in time, its publication was necessarily postponed.

It was determined by the Academy to resume its work as originally laid out, viz: by dividing the membership into appropriate sections, each section to devote itself as far as possible to original investigation. Several new members were elected, after which the meeting was adjourned.

FOR the Warner special prize of $200 for the best essay on comets, their composition, purpose and effect on the earth, 125 essays were sent to Director Swift, of Warner Observatory. The judges, Prof. Elias Colbert, of Chicago, Prof. H. A. Newton, of Yale College, New Haven, Conn., and Prof. H. M. Parkhurst, of New York City, unanimously awarded the prize to the essay written by Prof. Lewis Boss, director of Dudley Observatory, Albany, N. Y.

THE suggestions of Dr. John Fee, City Physician, in his late report to the Mayor and Council, are eminently practical and praiseworthy. Every one of them is based on experience, backed by a thorough knowledge of his profession, and the sooner the city avails itself of them the better it will be for all classes of its people.

THE destruction of the *World* Building by the late fire in New York was a serious loss to a number of the best papers published in the city. Among them were the *Scientific American* and *Scientific American Supplement*, the *Manufacturer and Builder*, and the *New York Observer*, all valued exchanges of the REVIEW. The *Scientific American*, while suffering severe loss, saved its account books, records and patent drawings, and, since its printing was done in another building, was enabled to proceed without interruption of its business. Its new offices are located at 261 Broadway, near Warren Street, a very central and convenient location and one that will soon become as well known to the people of the United States as "37 Park Row" has been for the past quarter of a century. We have not learned the new addresses of the other papers mentioned.

PROF. J. D. PARKER, who has frequently contributed to the columns of the REVIEW and who is otherwise well known as an able and scholarly man, has recently taken the position of business manager of the *Mid-Continent*, a religious and literary paper of this city.

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WE have received form Judge F. G. Adams, Secretary of the Kansas State Historical Society, at Topeka, a circular requesting its friends to send him for preservation books, pamphlets, old maps, letters, biographical sketches of old settlers, and, in brief, anything that can by the most liberal construction illustrate the history of Kansas, its early settlement, its progress and present condition. Doubtless hundreds of the older citizens of the State can and will aid materially in this matter, which should be one of pride and duty.

PROF. BROADHEAD notifies us of an error in the "Missouri Historical Notes," published last month, on page 630. It should read "Jackson County taken off Lillard in 1826," instead of 1820.

PROF. H. A. REID announces the discovery of zinc ore near Fairfield, in Marion County, Iowa, on the south side of the Des Moines River. The vein-rock is eight feet below the surface and about four feet thick.

Harper's Monthly for March is an excellent number. The articles are exceptionally interesting, and the illustrations very fine indeed. Prof. Simon Newcomb contributes an illustrated article entitled "A Small Telescope and What to See With It," which will be found both attractive and instructive. W. H. Bishop continues his "Typical Journeyings and Country Life in Mexico," while the poetry and fiction are fully up to the best magazine standard. The Editor's Department is all that can be asked.

Popular Science Monthly for March was received unusually early this month and is a valuable and entertaining number. In addition to the usual vigorous original and selected articles, the editor has recently introduced a new department entitled, "Entertaining Varieties," which will lend additional attractions to the magazine with ordinary readers.

WHILE other localities, east and west of us, have suffered from cold, our mercury has fallen below freezing but very few times during this winter, and as low as 10° above zero but twice altogether. We have had snow but twice and not more than an inch either time. Very little mud and no high water.

PROF. EDWIN F. SAWYER announces the discovery of a new variable star; Durchmusterung star 1° 3408, a variable of the Algol type with a period of a little less than five and a quarter days, the fluctuations in light being about three-fourths of a magnitude. The decrease to minimum occupies ten to twelve hours, and the increase a like interval of time. During the rest, or four-fifths of the period, it remains at its maximum brilliancy.

THE Kansas City REVIEW OF SCIENCE AND INDUSTRY for February is out with an excellent table of contents. Each successive number of Col. Case's valuable magazine seems better than its immediate predecessor.—*Kansas City Journal.*

BACK NUMBERS WANTED. All persons having spare copies of the REVIEW for June, 1879, or February, 1880, will receive a fair price for them upon returning them to the editor.

MAJ. S. HERSHEL, British engineer and grandson of the famous astronomer, is at Washington. He visits Washington upon invitation of Prof. Hilgard, of the coast and geodetic survey, to take part in certain nice pendulum observations for determining the exact force of gravity at this point. He brings pendulums used in similar experiments in England and India, and which are to be used at various points on the earth's surface to ascertain more precisely the actual formation of the sphere. Tests will be made at the Smithsonian Institution.

THE Royal Geographical Society, of London, has voted an appropriation of £10,000 for Leigh Smith's Arctic Expedition.